Missouri Early Learning Standards for Science

Content Component	Process Standards
I. Physical Science	1. Explores physical properties of objects and materials. 2. Investigates properties of objects and materials. 3. Solves problems involving physical properties of objects and materials. 4. Represents observations of the physical world in a variety of ways.
II. Life Science	1. Explores characteristics of living things. 2. Investigates characteristics of living things. 3. Solves problems related to living things. 4. Represents observations about living things in a variety of ways.
III. Earth and Space	1. Explores properties of earth and space. 2. Investigates properties of earth and space. 3. Solves problems involving earth and space. 4. Represents observations about earth and space in a variety of ways.

children with confidence in their own ability to work through problems are active thinkers

Organization

The standards cover the broad scope of child development and are organized by:

I. **Content Component** — the specific content area to be addressed, such as physical science or life science.

II. **Process Standards** — identifiable competencies or capabilities in the process of scientific development, such as investigating properties of objects and materials or exploring properties of earth and space.

III. **Indicators** — observable milestones in the development of competencies, such as experimenting with simple tools or showing interest in plant or animal changes.

IV. **Examples** — specific behaviors children may exhibit in their scientific thinking.

This structure provides us with an accessible way to see how the standards fit into our curriculum and teaching practices.

Introduction for Teachers

This guide, along with the *Parent Handbook,* is a companion to the *Missouri Early Learning Standards for Science*. It is intended for all adults who work with preschool-age children and their families — teachers, caregivers and/or parent educators. It explains the standards and contains practical suggestions for creating engaging, developmentally appropriate learning communities to foster each child's scientific thinking.

Why is it important to have standards in science for early learners? In Missouri, the Outstanding Schools Act of 1993 called together a group of master teachers, parents and policy-makers from around the state. The result of that group's work are the Show-Me Standards, which are designed for students in kindergarten through grade 12 and serve to ensure that graduates of Missouri's public schools have the knowledge, skills and competencies to lead productive, fulfilling and successful lives. However, we all realize the foundations for learning are laid well before a child enters kindergarten. Research tells us the early years provide crucial opportunities for educators and caregivers to influence children's growth and development. If our goal is that every child enters kindergarten ready to learn and succeed, pre-kindergarten educational standards can provide us with shared understandings about the competencies critical for this to occur. In addition, pre-kindergarten standards provide a direct link to the Show-Me Standards, so we know that we are preparing children for the high expectations they will encounter as they progress through school.

To this end, the *Missouri Early Learning Standards for Science* describe what most children should know and be able to do in the area of science by the time they enter kindergarten. They represent a shared set of expectations for preschool children that were developed by drawing upon current research about how young children learn. It is important to keep in mind, however, that children learn and develop in their own unique ways. While research demonstrates that these standards are appropriate for most children who are about to enter kindergarten, our responsibility as educators is to assess where each child is on the continuum of scientific thinking and build on what that child knows and can do.

Ongoing observational assessment is a key element in supporting children's early scientific development. This guide will illustrate some indicators that teachers can reliably assess to show each child's progress over time. This data can be used to plan meaningful, engaging learning experiences that promote both scientific development and a love for solving problems. In addition, you will find information about creating rich environments to support the construction of scientific knowledge as well as for partnering with parents and families to promote an interest in science and an enthusiasm for learning. Lists of teacher resources and children's books focused on science are also included.

I. Physical Science

Children are naturally interested in the objects and materials that constitute the physical world that surrounds them as well as in how objects and materials can be manipulated and changed. As they begin to explore these properties, they begin to build their knowledge about physical science.

1. Explores physical properties of objects and materials.

Indicators	Examples The child ...
a. Shows interest in the physical world.	• comments on changes in the physical world (e.g., says, "We made play dough out of salt, flour and water."). • looks at fiction and nonfiction books (e.g., *Mouse Paint*, *Trucks*, *Freight Train*, *Snow Balls*, *Stone Soup*, *How Things Work*) about the physical world.
b. Uses one or more senses to observe the physical world.	• comments on changes when substances are mixed, shaken or cooked (e.g., mixing paint, making butter from cream, cooking play dough). • collects objects of different shapes and sizes (e.g., marbles, coins, blocks). • listens to and identifies environmental sounds (e.g., cars, airplanes, wind, rain, birds).
c. Experiments with simple tools.	• explores ramps, magnets, magnifying glasses, scales, eyedroppers, unbreakable mirrors, cups, funnels, etc.

Teacher strategies to encourage children to explore the physical properties of objects and materials include:

- providing a variety of materials for children to use to manipulate and/or construct things (e.g., blocks of all sizes and shapes, tubes, ramps, pulleys, ropes, boxes).
- setting up learning centers for children to explore objects and materials. Center contents should be changed periodically to keep children interested.
- involving children in activities that involve transformation of materials (e.g., cooking, painting).
- making books about the physical world available to children in the literacy area and in other interest areas (e.g., block area, sensory area).
- reading books (including big books) aloud that feature aspects of the physical world.
- inviting visitors with a science-related vocation or hobby (e.g., scientists, construction workers, firefighters) to the classroom to discuss and/or demonstrate what they do and what equipment or tools they use.
- drawing children's attention to aspects of the physical world to promote their interest.
- asking open-ended questions to promote children's awareness of the physical world (e.g., asking, "What do you think happened to the snowball we left on the table?").
- modeling how to use simple tools to investigate and/or observe various objects (e.g., using a magnifying glass to look at a shell).
- encouraging children to make collections of objects they're interested in and engaging them in conversations about the objects.

I. Physical Science

Science is basically a process of inquiry — raising questions and then investigating methodically to answer them. Children have a natural curiosity about the world, and this curiosity provides the springboard for investigations that promote scientific thinking.

2. Investigates properties of objects and materials.

Indicators	Examples **The child ...**
a. Asks questions about objects and materials.	• asks, "Why does the ice cube melt?" • asks, "Why does this ball roll faster than that one?" • asks, "Why do magnets stick together?"
b. Experiments with objects and materials to gather information and observe reactions.	• plays in water with objects that sink and float. • repeatedly rolls a car down a ramp. • mixes colors using paint, watercolors, food coloring, etc.
c. Shows knowledge of physical properties of objects.	• sorts objects and materials by what they are made of (e.g., rock, metal, plastic, wood, glass, cloth). • sorts objects and materials by various characteristics (e.g., soft/hard, float/sink, loud/quiet). • tells (not always accurately) how ice, play dough, pudding, etc., is made.

Teacher strategies that promote children's investigations of the properties of objects and materials include:

- providing opportunities for them to manipulate objects and observe reactions (e.g., at the woodworking center, block area, light table, art area).
- modeling asking questions about objects/materials and encouraging children to find answers (e.g., asking, "I wonder how we can make the cars go down the ramp faster? How do you think we can find out?").
- giving children access to a variety of materials they can collect and engaging them in conversations about how they are sorting or classifying objects.
- modeling comparison language (e.g., wet/dry, shiny/dull, rough/smooth).
- supporting them in making observations about the physical world and making connections with what they already know or have observed.
- providing developmentally appropriate science software on the computer.

model how to use simple tools
to investigate and/or observe various objects

I. Physical Science

This standard refers to children's ability to identify and solve personally meaningful problems involving materials and objects they can manipulate and/or transform. As children work with things to solve problems of interest to them, they deepen their understanding of physics (interaction of matter and energy) and chemistry (how substances interact and change).

3. Solves problems involving physical properties of objects and materials.

Indicators	Examples The child ...
a. Identifies problems involving physical properties of objects and materials.	• says, "I want the car to go faster." • says, "I want to build a taller tower." • says, "I have red, blue and yellow paint, but I want green."
b. Experiments with objects to produce desired effects.	• moves the ramp to make a toy car go different speeds. • tries to make a new color of paint by mixing other paint colors. • tries to throw a ball at a target.
c. Makes predictions based on experiences with objects and materials.	• suggests which objects will sink or float. • guesses which ramp the car will go down faster. • predicts which objects magnets attract or repel (e.g., leaves, cotton balls, paper clips, nuts and bolts). • makes suggestions that will cause ice to melt faster.

Teacher strategies that promote problem solving with objects and materials include:

- asking open-ended questions (e.g., asking "How can we make the car go farther?" or "What happened when the magnet touched the paper clip?").
- taking advantage of spontaneous happenings to encourage problem solving with substances and objects (e.g., at snack time when something spills; in the block area as children attempt to construct tall towers).
- providing children with enough time and space to work with objects and materials and pursue their own inquiries (e.g., constructing with blocks).
- supplying a variety of materials for children to experiment with (e.g., to see what sinks or floats at the water table; to see how far objects such as feathers or pieces of paper go when they blow at them through straws).
- engaging children in predicting what will happen as they experiment.
- providing opportunities for children to test their predictions.
- encouraging children to build on what they know by making connections with other experiences they've had with objects and materials.

I. Physical Science

This standard refers to children's ability to demonstrate, in various ways, what they perceive through their senses as they experience the physical world. This skill is another building block for scientific thinking and provides a means for children to communicate their ideas about the physical world and how it works.

4. Represents observations of the physical world in a variety of ways.

Indicators	Examples **The child ...**
a. Represents observations through pretend play.	• pretends to prepare/cook food. • uses simple tools (e.g., magnets, magnifying glasses, ramps, tape measures, balls, prisms) in pretend play. • engages in role playing (e.g., acts like a scientist, chef, construction worker, artist, race car driver/pit crew member).
b. Represents observations through music and movement.	• pretends to skate on ice. • acts out a melting snowman, popping popcorn, an object rolling down a hill. • sings action songs (e.g., *I'm a Little Teapot*, *Johnny Works With One Hammer*, *Grand Old Duke of York*, *Jack and Jill Went Up the Hill*). • creates songs about experiences in the physical world.
c. Represents observations through art and construction.	• builds and/or draws towers, enclosures, roads, bridges, tunnels, ramps and vehicles. • intentionally mixes blue and yellow paint to make green. • draws "maps" or "blueprints" of constructions.
d. Talks about the physical world.	• asks, "How did you do that?" • tells a friend, "If you add another block to the tower, it will fall." • describes objects according to size, shape, color or speed. • uses names for tools (e.g., magnifying glass, magnet, scale, ramp). • uses texture words (e.g., bumpy, rough, soft, smooth, slick, hard). • uses measurement words (e.g., heavy/light, hot/cold, big/little, long/short, fast/slow).

Teacher strategies for promoting children's representation of their observations include:

- engaging them in conversations about the physical world.
- encouraging them to represent their observations in many different media as well as through language.
- engaging them in musical experiences and songs where they act out their observations (e.g., swaying in the wind).
- providing resources and opportunities for them to experiment with writing or drawing their observations (e.g., a block structure, a tower).
- providing appropriate props for children to role play.
- supplying the classroom with posters, books and magazines about the physical world and its phenomena.
- modeling use of vocabulary to describe the physical world (e.g., measurement and texture words, names of tools).
- providing many opportunities (e.g., at circle time, during center time) for children to represent their ideas about how the physical world works and to exchange their ideas with their peers.

engage children in conversations about the physical world

II. Life Science

This standard concerns the child's developing understanding of the difference between living and nonliving things as well as of how living things grow and change. Because young children are active learners, they build their knowledge through direct experience with living things in the environment and in the classroom.

1. Explores characteristics of living things.

Indicators	Examples **The child ...**
a. Shows interest in plant and animal changes.	• comments on changes in living things (e.g., babies grow to adults, seeds become plants, caterpillars become butterflies, birds hatch from eggs). • remarks that the leaves are changing colors, the trees have buds, the flowers are blooming. • looks at books, magazines and posters that feature living things (e.g., *The Very Hungry Caterpillar*; *Ranger Rick's Your Big Back Yard*; *Zoo Book*; magazines and posters from the Missouri Department of Conservation).
b. Uses one or more senses to observe the natural world.	• expresses wonder/excitement about living things (e.g., rabbits, deer, fish, spiders, birds, blooming flowers). • says, "I hear the birds singing," or "The dog is barking." • says, "I smell a skunk," or "Smell this flower." • comments on the different tastes of food. • holds or watches a caterpillar or worm to see how it moves. • catches bugs and places them in a container. • uses a magnifying glass to observe living things. • examines leaves, pine cones, shells, etc.

Teacher strategies to support children's exploration of the characteristics of living things include:

- keeping a class pet (or an aquarium, ant farm, etc.) and encouraging children to observe and care for the creature.
- engaging children in sensory experiences with natural objects or living things (with appropriate care and safety considerations in mind).
- drawing children's attention to living things in the environment when opportunities arise.
- taking children on nature walks and/or explorations of the playground to discover what lives there.
- providing opportunities for children to make collections of seeds, leaves, pine cones, etc., as well as to discuss the characteristics of what they collect.
- supplying the classroom with nonfiction books that are about living things and that illustrate the life cycle.
- engaging the children in planting seeds (indoors and outdoors) and observing how plants grow and change.

provide opportunities for children to collect seeds, leaves, pine cones, etc., as well as to discuss the characteristics of what they collect

II. Life Science

Young children are fascinated by the attributes of living things as well as by the transformations living things (including themselves) exhibit as they develop and move through the cycle of life. Children's natural curiosity and wonder can be the inspiration for beginning scientific inquiry and early investigations about the natural world.

2. Investigates characteristics of living things.

Indicators	Examples The child ...
a. Asks questions about the natural world.	• asks, "Why didn't the seed grow?" • asks, "Where do babies come from?" • asks, "Where do the frogs go in winter?" • asks, "How do fish breathe?" • asks, "What do animals eat?"
b. Collects information to learn about living things.	• collects leaves, pine cones, shells, seeds, bugs, etc. • uses a magnifying glass to investigate a spider web. • uses real or pretend binoculars to observe nature (e.g., birds, trees). • looks at books and magazines to learn about living things.
c. Shows knowledge of the characteristics of living things.	• matches mother animals with their babies using pictures, stuffed animals, animal matching games, animal figurines, etc. • sorts collections (e.g., leaves, pine cones, shells, seeds, bugs). • talks about the differences in animals (e.g., birds have feathers, fish live in water, dogs and cats have fur). • identifies living versus nonliving things (e.g., says, "That's just a plastic snake!").

Teacher strategies to promote children's investigations into the characteristics of living things include:

- asking children questions to engage their interest about living things they can observe in the classroom or outdoors (e.g., asking, "Where do you think the toad lives?" or "Why do you think these leaves are drooping?").
- using children's questions and interest about specific living things (e.g., spiders, plants) to engage them in projects that will extend throughout the curriculum.
- reading aloud books about living things and the life cycle and engaging children in conversations about this information.
- prompting discussions about how the human body works by asking questions (e.g., asking, "How do you know when you're hungry?").
- giving children opportunities to handle animals, insects, reptiles, etc., in order to explore their characteristics (keeping health and safety considerations in mind).
- giving children access to resources so they can make their own collections of artifacts from the natural world (e.g., shells, seeds and seed pods, leaves, feathers).
- encouraging children to represent their observations and ideas about living things in a variety of media as well as through language.

give children access to resources
so they can make their own collections
of artifacts from the natural world

II. Life Science

This standard reflects children's ability to identify and attempt to solve problems involving living things and the natural world. It is important to keep in mind, however, that children's "solutions" may not always be accurate. In fact, these errors in thinking are part of a developmental process as children construct their knowledge about living things and the natural world.

3. Solves problems related to living things.

Indicators	Examples The child ...
a. Identifies problems involving living things.	• comments that the plant is drooping (wilting). • complains that the animal cage is smelly. • says, "I can't play outside because the bugs will bite."
b. Recognizes that living things have needs.	• says, "The plant needs water." • says, "I'm hungry." • says, "The dog wants to play."
c. Makes predictions based on experiences with living things.	• says, "I think a baby chick will come out of the egg." • says, "If we don't water the plant, it will die." • says, "When the dog brings the ball, he wants to play." • says, "When the baby cries, she needs you."

Teacher strategies to support children's problem solving related to living things include:

- acknowledging their observations about changes involving living things (including human beings) and helping them make connections between cause and effect(s).
- modeling appropriate care of living things (e.g., plants, animals, reptiles, themselves).
- reading aloud books that deal with problems of living things.
- asking questions to promote their problem solving (e.g., asking, "Why do you think the cage is smelly?").
- giving them many opportunities to observe and interact with living things (indoors and outdoors).
- modeling wonder and interest in the natural world.

II. Life Science

This standard refers to children's ability to express what they perceive through their senses as they experience the natural world and interact with living things. It also refers to children's growing awareness of their own selves/bodies as part of the natural world. This skill is another building block for scientific thinking and provides a means for children to communicate their ideas about nature and the life cycle.

4. Represents observations about living things in a variety of ways.

Indicators	Examples The child ...
a. Represents observations through pretend play.	• Engages in role playing (e.g., plays a veterinarian, gardener, doctor, farmer, florist, parent). • pretends to be an animal (e.g., dog, elephant, bird).
b. Represents observations through music and movement.	• moves like an elephant, spider or snake. • sings songs about living things (e.g., *Six Little Ducks*, *Old MacDonald Had a Farm*, *Five Little Speckled Frogs*, *Baby Bumble Bee*, *And the Green Grass Grew All Around*, *Sweetly Sings the Donkey*). • creates songs about living things.
c. Represents observations through art and construction.	• draws or paints pictures of animals. • uses blocks to build a farm or zoo. • draws or paints pictures of his own family.
d. Talks about plants and animals.	• tells about family pets, trips to the zoo, etc. • comments on how to care for a pet. • uses words such as leaf, tree and flower in conversation. • uses names of living things (e.g., elephant, cow, bird, fish, dog, spider, insect, flower, tree, grass). • uses words such as beak, wings, skin, shell, claws, head, tail, feathers, horns and fur in conversation.

Teacher strategies to support children's ability to represent their observations about living things include:

- providing an ample supply of blocks and animal and human figures as well as adequate space and time for children to play with them and to discuss their actions and creations.
- providing opportunities for children to represent their observations from the zoo, a field trip, etc., by making a class book.
- inviting visitors with a vocation or hobby involving living things or the natural world (e.g., veterinarian, farmer, nurse) into the classroom.
- supporting children's pretend play concerning living things and places where living things are found (e.g., zoo, circus, farm, doctor's office).
- modeling the vocabulary used to describe the characteristics of living things.
- supplying the classroom with appealing books involving living things and the natural world.
- engaging children in music and/or movement activities where they can imitate living things and the sounds they make.
- supporting children's attempts to make pictures or sculptures (e.g., with play dough or modeling clay) of living things.
- encouraging children to "write" about their observations (e.g., in a daily journal, in letters to grandparents).
- engaging children in conversations about their observations (e.g., at morning meeting, while working in learning centers).

invite visitors with a vocation or hobby
involving living things or the natural world
into the classroom

III. Earth and Space

This standard refers to children's interest in and curiosity about earth and space. These abstract concepts start to become meaningful as children begin to observe the earth and sky and their characteristics and phenomena.

1. Explores properties of earth and space.

Indicators	Examples The child ...
a. Shows interest in earth and space.	• comments on changes in the weather, clouds or seasons. • looks at books and magazines about earth and space (e.g., *In the Night Sky*; *Happy Birthday Moon*; *Goodnight Moon*; *In the Small, Small Pond*; *The Snowy Day*; *Mud Puddle*; *Let's Go Rock Collecting*; *Star Gazers*; *Ranger Rick's Your Big Back Yard*).
b. Uses one or more senses to observe earth and space.	• plays with, collects and examines rocks, soil (dirt), mud, sand, shells, etc. • notices shadows. • says, "I hear the rain (thunder, wind)." • looks at the clouds, the stars and the moon.
c. Uses simple tools to explore earth and space.	• uses a sand sifter, garden tools, etc., to explore the dirt, mud, sand and rocks. • uses a flashlight to make shadows. • plays with measuring devices (e.g., thermometer, rain gauge, ruler, cup, bowl). • experiments with windsocks, pinwheels, telescopes, binoculars, kites, magnifying glasses, etc.

Teacher strategies to support children's exploration of the properties of earth and space include:

- drawing their attention to weather and changes in weather and the seasons and engaging them in conversations about what they see, hear and feel.
- supplying the classroom with books and magazines about earth and space.
- providing them with opportunities to play with soil (dirt), sand and mud.
- equipping the sand and/or water table with simple tools and measuring devices (e.g., sifters, trowels, hand rakes and hoes, measuring cups).
- engaging them in shadow play.
- setting up a learning center with a light table.
- reading aloud stories about earth and space, the moon and stars, etc.
- encouraging them to make rock collections.

III. Earth and Space

Young children's knowledge about earth and space is constructed in very concrete ways through "hands-on, minds-on" investigations of materials and processes that are meaningful to them. This standard refers to these early attempts to find out about the earth and space.

2. Investigates properties of earth and space.

Indicators	Examples **The child asks ...**
a. Asks questions about earth and space.	• "How do you make mud?" • "Why is this rock shiny?" • "What makes the thunder and lightning?" • "What happened to the snow?" • "Why is the moon out in the daytime?" • "Where does the sun go to sleep?" • "Why is the moon following me?"
b. Conducts experiments to gain knowledge of earth and space.	• adds water to soil (dirt) to make mud. • looks for rocks that will write on concrete. • tries to change rocks (e.g., breaks them into smaller pieces or makes them shiny by using water or oil). • paints with water on outside surfaces.
c. Shows knowledge of changes in earth and space.	• comments on changes in the weather, clouds, temperature, daylight and darkness. • says, "The moon is different tonight." • comments on changes in puddles, grass, soil, sand, wood chips, etc.

Teacher strategies to promote children's investigations of the properties of earth and space include:

- providing many opportunities for children to play with sand and water and supporting their conversations about their actions and experiments.
- asking open-ended questions to encourage children's investigations (e.g., asking, "Why do you think the puddle is gone?").
- providing an outdoor area where children can dig, play in water, etc.
- encouraging children to make observations and comparisons about the sky, the weather and the seasons.
- providing opportunities for children to explore the attributes of various rocks and minerals, different kinds of dirt/soil, etc.

III. Earth and Space

The standard refers to children's ability to identify and solve personally meaningful problems related to earth and space. As children begin to build theories to solve problems that are of interest to them, they deepen their understanding of the environment in which they live. Their theories may not be accurate, but the process of identifying a problem and thinking it through is the foundation for the development of reasoning and scientific thought.

3. Solves problems involving earth and space.

Indicators	Examples The child says ...
a. Identifies problems involving earth and space.	• "There is no grass under the slide." • "It's cold outside." • "I can't walk on the sidewalk (sand). It is too hot." • "My shoes got wet when I stepped in the puddle." • "I can't dig in this hard dirt."
b. Makes predictions based on experiences with earth and space.	• "I hear thunder. It's going to rain." • "We get to play outside because it is sunny." • "I think the snow will melt because the sun is shining." • "I might fall on the ice." • "If it snows too much, we can't go anywhere." • "Water and dirt make mud."

Teacher strategies for promoting children's ability to solve problems related to earth and space include:

- taking advantage of spontaneous happenings during the day to encourage problem solving (e.g., going outdoors after rain has caused puddles to form).
- providing children with enough time and space to play with sand, water, soil/dirt, rocks, etc., and pursue their own inquiries.
- engaging children in shadow play.
- engaging children in predicting what will happen as they experiment.
- providing opportunities for children to test their predictions.
- encouraging children to make connections with other experiences they've had in order to build on what they know about the earth, sky, weather, seasons, etc.

III. Earth and Space

This standard reflects children's growing ability to communicate their observations about earth and space in a variety of ways as well as through language. As the child becomes more aware of the elements and features of earth and space, she begins to communicate her observations and understandings.

4. Represents observations about earth and space in a variety of ways.

Indicators	Examples The child ...
a. Represents observations through pretend play.	• engages in role playing (e.g., plays a weather person, astronaut, farmer). • dresses dolls, puppets or flannel-board characters according to the weather. • uses simple tools (e.g., magnifying glasses, binoculars, telescopes, scales, maps, digging tools, brushes, buckets) to pretend.
b. Represents observations through music and movement.	• moves like the wind, snowman, snowflake, rocket, astronaut in space, tornado, dinosaur, etc. • sings songs such as *Twinkle, Twinkle, Little Star*; *The Itsy, Bitsy Spider*; *Hey Diddle Diddle*; and *If All the Raindrops Were Lemondrops and Gumdrops*. • creates songs about earth and space.
c. Represents observations through art and construction.	• makes landscapes with mud, sand and water. • draws or paints pictures of the sky, moon, stars, sun, earth, etc. • uses play dough or blocks to make mountains, snowmen, spaceships, caves, dinosaurs, etc.
d. Talks about earth and space.	• describes rocks according to size, shape and color. • says, "The moon and stars come out at night." • talks about night and day. • talks about winter, spring, summer and fall. • uses earth words (e.g., soil, ocean, mountain, sand, rock, river, lake, creek). • uses weather words (e.g., rainy, windy, snowy, foggy, sunny, cloudy, temperature). • uses seasonal words (e.g., winter, spring, summer and fall). • uses space words (e.g., moon, star, sun, sky, air).

Teacher strategies for supporting children's representations of earth and space include:

- asking open-ended questions (e.g., why and how questions) to engage children in conversations about elements of earth and space.
- encouraging children to represent their observations about the seasons, clouds, rivers, mountains, and other components of earth and space in many different media as well as through language.
- engaging children in musical experiences and songs in which they act out their observations (e.g., twirling like a snowflake).
- providing resources and opportunities for children to experiment with writing or drawing their observations (e.g., of a thunder storm, of the night sky).
- inviting guests (e.g., miners, geologists, weather forecasters) to the classroom to discuss and/or demonstrate what they do and what equipment or tools they use.
- providing appropriate props for children to role play.
- supplying the classroom with posters, books and magazines about earth and space.
- modeling vocabulary associated with earth and space (e.g., weather and seasonal words, names of tools).
- providing many opportunities (e.g., at circle time, during center time) for children to represent their ideas about earth and space and to exchange their ideas with their peers.

supply the classroom with posters, books and magazines about earth and space

Creating an Environment to Promote Scientific Thinking

An environment that promotes children's interest in science is one that stimulates inquiry and experimentation. For young children, the process of scientific thinking begins with wonder and questioning. Supplying the classroom and science area with interesting artifacts from the physical and natural worlds as well as with simple scientific instruments and tools such as magnifying glasses, scales and other measuring devices, a variety of containers, tubes, and sand and water tables will lay the foundation for children's investigations and problem solving. An ample supply of blocks, rollers, ramps, ropes and pulleys, balls and pendulums, etc., will also inspire children to experiment with objects. Providing a supply of found materials (e.g., rocks, shells, pine cones) for children to explore is also helpful. Periodically introducing new items and rotating others helps keep children's interest. In addition, when thinking about enhancing the environment to support children's scientific thinking, it is important to remember that science can extend across all curricular areas. For example, the art area also lends itself naturally to children's investigations and experiments with paint, play dough and clay. Including a wide variety of picture books and texts about nature, earth and space, and the physical world in the literacy center will also support children's scientific thinking. And remember, equipping a classroom for scientific inquiry need not be expensive. A plastic tub can serve as a water table, found objects and recyclables can serve to promote children's experiments and investigations, and the outdoors is a great laboratory!

Involving Parents and Families

Partnering with parents and families to support children's scientific thinking can be both rewarding and fun. Encouraging families to involve their children in cooking, to take "field trips" around their yards or neighborhoods to observe nature or make collections of interesting rocks, leaves, nuts, etc., or to observe the moon and stars are wonderful ways to involve families in the science curriculum. Lending books that feature scientific topics and the natural world is another way to both promote interest in science and literacy development. In addition, collecting artifacts or information for class projects can turn into family endeavors. There are many resources for educators interested in involving parents in supporting their children's scientific thinking; many are included in this handbook. The Parents as Teachers program is also a wonderful resource; contact your school district for more information about this exemplary program.

Resources

Books:

Anderson, A., Diehn, G., and Krautwurst, T. (1998). *Geology crafts for kids: 50 nifty projects to explore the marvels of planet earth*. New York, NY: Sterling Publishing.

Blobaum, C. (1999). *Geology rocks! 50 hands-on activities to explore the earth*. Charlotte, VT: Williamson Publishing Co.

Bredekamp, S., and Rosegrant, T. (Eds.). (1995). *Reaching potentials (Vol. 2): Transforming early childhood curriculum and assessment*. Washington, DC: National Association for the Education of Young Children.

Carmichael, V.S. (1982). *Science experiences for young children*. Palo Alto, CA: R & E Research Associates.

Chaille, C., and Britain, L. (1991). *The young child as scientist: A constructivist approach to early childhood science education*. New York, NY: HarperCollins.

Cohen, R. and Tunick, B.P. (1997). *Snail trails and tadpole tails: Nature education guide for young children*. St. Paul, MN: Redleaf Press.

Cornell, J. (1998). *Sharing nature with children*. Nevada City, CA: Dawn Publications.

Diehn, G., and Krautwurst, T. (1997). *Kid style: Nature crafts: 50 terrific things to make with nature's materials*. New York, NY: Sterling Publishing.

Diehn, G., and Krautwurst, T. (1997). *Science crafts: 50 fantastic things to invent and create*. New York, NY: Sterling Publishing.

Diener, C.S., Jettinghoff, C.R., Robertson, E.B., and Stickland, M.P. (1982). *Energy: A curriculum unit for three, four, and five year olds*. Atlanta, GA: Humanics Limited.

Fiarotta, P. (1975). Snips and snails and walnut shells: *Nature crafts for children*. New York, NY: Workman Publishing Company.

Gertz, S.E., Portman, D.J., and Sarquis, M. (1996). *Teaching physical science through children's literature*. Middletown, OH: Terrific Science Press.

Goodwin, M.T., and Pollen, G. (1980). *Creative food experiences for children* (Rev. ed.). Washington, DC: Center for Science in the Public Interest.
Green, M.D. (1998). *Themes with a difference: 228 new activities for young children*. Albany, NY: Delmar.
Hickman, P.M. (1988). *Birdwise: Forty fun feats for finding out about our feathered friends*. Reading, MA: Addison-Wesley Publishing.
Hickman, P.M. (1990). *Bugwise: Thirty incredible insect investigations and arachnid activities*. Reading, MA: Addison-Wesley Publishing.
Hill, D.M. (1977). *Mud, sand, and water*. Washington, DC: National Association for the Education of Young Children.
Holt, B.-G. (1989). *Science with young children* (Rev. ed.). Washington, DC: National Association for the Education of Young Children.
Horsfall, J. (1997). *Play lightly on the earth: Nature activities for children 3 to 9 years old*. Nevada City, CA: Dawn Publications.
Kamii, C., and DeVries, R. (1978/1993). *Physical knowledge in preschool education: Implications of Piaget's theory*. New York, NY: Teachers College Press.
Katz, A. (1986). *Naturewatch*. Reading, MA: Addison-Wesley.
Kohl, M.F. (1992). *Mudworks: Creative clay, dough, and modeling experiences*. Bellingham, WA: Bright Ring Publishing.
Kohl, M.F., and Gainer, C. (1991). *Good earth art: Environmental art for kids*. Bellingham, WA: Bright Ring Publishing.
Kohl, M.F., and Potter, J. (1993). *Science arts: Discovering science through art experiences*. Bellingham, WA: Bright Ring Publishing.
Kraul, W. (1995). *Earth, water, fire and air: Playful explorations in the four elements*. Mt. Rainier, MD: Gryphon House.
Lawton, R., Lawton, D., and Panttaja, S. (1997). *Discover nature in the rocks: Things to know and things to do*. Mechanicsburg, PA: Stackpole Books.
Linglebach, J. (Ed.) (1989). *Hands-on nature: Information and activities for exploring the environment with children*. Woodstock, VT: Vermont Institute of Nature Science.
Milord, S. (1996). *The kids' nature book: 365 indoor/outdoor activities and experiences*. Charlotte, VT: Williamson Publishing.
Mitchell, J. (1996). *The curious naturalist*. Lincoln, MA: Massachusetts Audubon Society.
National Wildlife Federation. (1997). New York, NY: McGraw-Hill.
Ranger Rick's Naturescope: Birds, birds, birds!
Ranger Rick's Naturescope: Wild about weather.
Ranger Rick's Naturescope: Astronomy adventures.
Ranger Rick's Naturescope: Wading into wetlands.
Ranger Rick's Naturescope: Endangered species: Wild and rare.
Ranger Rick's Naturescope: Geology: The active earth.
Ranger Rick's Naturescope: Let's hear it for herps.
National Wildlife Federation. (1998). New York, NY: McGraw-Hill.
Ranger Rick's Naturescope: Trees are terrific!
Ranger Rick's Naturescope: Amazing mammals: Part 1.
Ranger Rick's Naturescope: Amazing mammals: Part II.
Ranger Rick's Naturescope: Incredible insects.
Ranger Rick's Naturescope: Pollution: Problems and solutions.
Needham, B. (1998). *Ecology crafts for kids: 50 great ways to make friends with planet earth*. New York, NY: Sterling Publishing Company.
Neugebauer, B. (Ed.). (1996). *The wonder of it: Exploring how the world works*. Redmond, WA: Child Care Information/Exchange Press.
Nickelsburg, J. (1976). *Nature activities for early childhood*. Reading, MA: Addison-Wesley.
Rhoades, D. (1998). *Garden crafts for kids: 50 great reasons to get your hands dirty*. New York, NY: Sterling Publishing Company.
Sisson, E.A. (1982). *Nature with children of all ages: Activities and adventures for exploring, learning, and enjoying the world around us*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
Suzuki, D. (1992). *Looking at insects*. New York, NY: John Wiley and Sons.
VanCleave, J. (1996). *Rocks and minerals: mind-boggling experiments you can turn into science fair projects*. New York, NY: John Wiley and Sons.
VanCleave, J. (1998). *Insects and spiders: mind-boggling experiments you can turn into science fair projects*. New York, NY: John Wiley and Sons.
VanCleave, J. (2000). Science around the year. New York, NY: John Wiley and Sons.
Williams, R.A., Rockwell, R.E., and Sherwood, E.A. (1990). Mudpies to magnets: A preschool science curriculum. Mt. Rainier, MD: Gryphon House.

Magazines:

- *Early Childhood News* (6 issues per year)
  330 Progress Road
  Dayton OH 45449
  1-800-607-4410
- *Scholastic Early Childhood Today* (8 issues per year)
  P.O. Box 54814
  Boulder CO 80322-4814
  1-800-544-2917
- *Young Children* (6 issues per year)
  National Association for the Education of Young Children (NAEYC)
  1509 16th Street, NW
  Washington DC 20036-2460
  1-800-424-2460

Web sites:

- Association for Childhood Education International — www.udel.edu/bateman/acei
- Early Childhood Education on Line — www.ume.maine.edu/ECEOL-L
- Early Childhood Educators' and Family Web Corner — users.sgi.net/~cokids
- Everything for Early Childhood Education Preschool-Grade 2 — www.edupuppy.com
- Houghton Mifflin K-8 Education Place: Science Center — eduplace.com/science/index.jsp
- Missouri Department of Conservation Teacher's Page — mdc.mo.gov/teacher
- Missouri DESE Early Childhood — dese.mo.gov/divimprove/fedprog/earlychild/index.html
- National Association for Family Child Care — www.nafcc.org
- National Institute for Early Education Research — nieer.org
- On-Lion for Kids! — kids.nypl.org
- Project Construct National Center — www.projectconstruct.org
- The Southern Early Childhood Association online position statements — www.southernearlychildhood.org/position.html
- U.S. Department of Health and Human Services National Child Care Information Center — www.nccic.org
- University of Connecticut Connections Newsletters — www.canr.uconn.edu/ces/child
- University of Illinois Early Childhood and Parenting (ECAP) Collaborative — ecap.crc.uiuc.edu

Children's books:

Air and water: *Small Cloud* — Ariane; *Water* — Frank Asch; *Wind* — Ron Bacon; *Air Is All Around You* — Franlyn M. Branley; *Follow the Water From Brook to Ocean* — Arthur Dorrors; *A Drop of Water* — Walter Wick.

Amphibians: *All About Frogs* — Jim Aronsky; *Marsh Music* — Marianne Berkes; *Salamanders* — Emery Bernhard; *Toad* — Ruth Brown; *Amphibian: Eyewitness Books* — Barry Clarke; *Can You Find Me? A Book About Animal Camouflage* — Jennifer Dewey; *Why Frogs Are Wet* — Judy Hawes.

Animals: *I Was Walking Down the Road* — Sarah E. Barchas; *One Earth, a Multitude of Creatures* — Peter Roop and Connie Roop; *What's Inside? Small Animals* — Angela Royston; *When Animals Are Babies* — Elizabeth Schwartz.

Aquatic life: *Otters Under Water* — Jim Aronsky; *Around the Pond* — Ann Cooper; *My River* — Shari Halpern; *The River: A First Discovery Book* — Gallimard Jeunesse and Laura Bour; *Pond Year* — Kathryn Lasky; *Look Closer: Pond Life* — Barbara Taylor; *The Beaver Pond* — Alvin Tresselt.

Birds: *Birds: A First Discovery Book* — Claude Delafosse and Rene Mettler; *How Do Birds Find Their Way?* — Roma Gans; *The Barn Owls* — Tony Johnston; *About Birds: A Guide for Children* — Cathryn Still; *Have You Seen My Duckling?* — Nancy Tafuri.

Caves: *A Journey Through Time: The Cave Painter of Lascaux* — Roberta Angeletti; *First Look: Under The Ground* — Daphne Butler; *Look Closer: Cave Life* — Christine Gunzi; *Painters of the Caves* — Patricia Lauber; *Looking Inside Caves and Caverns* — Ronald Schultz.

Energy: *Switch On, Switch Off* — Melvin Berger; *All About Electricity* — Melvin Berger; *Who Likes the Sun?* — Beatrice Schenk DeRegniers; *Sun Up, Sun Down* — Gail Gibbons; *The True Book of Energy* — Illa Pondendorf.

Fish: *The Little Fish That Got Away* — Bernadine Cook; *Blue Sea* — Robert Kalan; *Swimmy* — Leo Lionni; *What's It Like To Be a Fish?* — Wendy Pfeffer; *Fishes* — Brian Wildsmith.

Food chains: *Bugs for Lunch* — Margery Facklam; *What About Ladybugs?* — Celia Godkin; *What Do You Do When Something Wants To Eat You?* — Steve Jenkins; *Eat and Be Eaten* — Iela Mari; *Watch Where You Go* — Sally Noll.

Habitat: *Homes in the Ground* — Susan Canizares Mary Reid; *In the Woods* — Ermanno Cristini and Luigi Puricelli; *In the Tall, Tall Grass* — Denise Fleming; *The True Book of Animal Homes* — Illa Pondendorf; *What Lives in a Shell?* — Kathleen Weidner Zoehfeld.

Harvest: *Raccoons and Ripe Corn* — Jim Aronsky; *Pelle's New Suit* — Elsa Besckow; *Picking Apples and Pumpkins* — Amy Hutchings; *Apples and Pumpkins* — Anne Rockwell; *Autumn Harvest* — Alvin Tresselt; *Working Cotton* — Sherley Anne Williams.

Insects: *Ladybug, Ladybug* — Ruth Brown; *What Do Insects Do?* — Susan Canizares and Pamela Chanko; *Insects* — John Grassy; *From Caterpillar to Butterfly* — Deborah Heiligman; *How to Hide a Butterfly and Other Insects* — Ruth Heller; *Bugs, Bugs, Bugs!* — Mary Reid and Betsey Chessen.

Land use: *Common Ground: The Water, Earth and Air We Share* — Molly Bang; *Building a House* — Byron Barton; *The First Snowfall* — Anne Rockwell and Harlow Rockwell; *City in Summer* — Eleanor Schick; *Letting Swift River Go* — Jane Yolen.

Mammals: *Big Tracks, Little Tracks* — Franklyn M. Branley; *Animal Tracks* — Arthur Dorros; *The Milk Makers* — Gail Gibbons; *Animals Born Alive and Well* — Ruth Heller; *Chipmunk at Hollow Tree Land* — Victoria Sherro; *The Rabbit Story* — Alvin Tresselt.

Old-time days: *Charlie Needs a Cloak* — Tomie dePaola; *Pancakes for Breakfast* — Tomie dePaola; *General Store* — Rachel Field; *Native American Rock Art: Messages From the Past* — Yvette LaPierre; *Who Came Down That Road?* — George Ella Lyon.

Plants and flowers: *Flower Garden* — Eve Bunting; *Growing Vegetable Soup* — Lois Ehlert; *From Seed to Plant* — Gail Gibbons; *The Reason for a Flower* — Ruth Heller; *The Carrot Seed* — Ruth Krauss.

Recycling and pollution: *The Earth and I Are Friends* — Frank Asch; *Recycle: A Handbook for Kids* — Gail Gibbons; *The Compost Heap* — Harlow Rockwell; *Litterbugs Come in Every Size* — Norah Smaridge.

Reptiles: *All About Alligators* — Jim Aronsky; *All About Rattlesnakes* — Jim Aronsky; *All About Turtles* — Jim Aronsky; *Can You Find Me? A Book About Animal Camouflage* — Jennifer Dewey; *Turtles and Snails: A First Discovery Book* — Gallimard Jeunesse and Gilbert Houbre; *The Fascinating World of Snakes* — Maria Angels Julivert; *Eyes on Nature: Lizards* — Robert Matero.

Rocks: *Fossils Tell of Long Ago* — Aliki; *Earthquakes* — Franklyn M. Branley; *Volcanoes* — Franklyn M. Branley; *The Pebble in My Pocket* — Meredith Hooper; *On My Beach There Are Many Pebbles* — Leo Lionni; *Hobby Handbooks: Rocks and Fossils* — Ray Oliver.

Seasons: *Spring* — Asun Balzola and J.M. Parramon; *A Winter Day* — Douglas Florian; *A Pocketful of Seasons* — D.V. Foster; *Fresh Fall Leaves* — Betsy Franco; *On a Summer Day* — Lois Lenski; *Seeing Science Through Art: Sky Tree* — Thomas Locker.

Seeds: *The Dandelion Seed* — Joseph Anthony and Cris Arbo; *All About Seeds* — Melvin Berger; *The Tiny Seed* — Eric Carle; *Apples* — Gail Gibbons; *From Seed to Plant* — Gail Gibbons; *The Reason for a Flower* — Ruth Heller; *How a Seed Grows* — Helene J. Jordan.

Shadows: *What Makes a Shadow?* — Clyde Robert Bulla; *The Shadow Book* — Beatrice Schenk DeRegniers; *Footprints and Shadows* — Anne Wescott Dodd; *Me and My Shadow* — Arthur Dorros; *Shadows* — Carolyn G. Otto.

Soil: *Deep Down Underground* — Oliver Dunrea; *The Pottery Place* — Gail Gibbons; *Muddigush* — Kimberly Knutson; *Under Your Feet* — Joanna Ryder; *Our Earthworms* — Herbert H. Wong.

Spiders: *Spider's Web* — Christine Back; *Spiders* — Gail Gibbons; *Be Nice to Spiders* — Margaret Bloom Graham; *Outside and Inside Spiders* — Sandra Markel; *I Love Spiders* — John Parker.

Trees and forests: *Look at a Tree* — Eileen Curran; *From Tree to Paper* — Wendy Davis; *Mr. Tamarin's Trees* — Kathryn Ernst; *A Carpenter* — Douglas Florian; *The Tree in the Ancient Forest* — Carol Reed-Jones; *Johnny Maple-Leaf* — Alvin Tresselt.

Weather: *Flash, Crash, Rumble and Roll* — Franklyn M. Branley; *The Cloud Book* — Tomie dePaola; *Snowballs* — Lois Ehlert; *Thundercake* — Patricia Polacco; *The First Snowfall* — Anne Rockwell and Harlow Rockwell; *It Looked Like Spilt Milk* — Charles G. Shaw.