Teaching SCIENCE Through the Visual Arts and Music
"LOOK, LOOK," exclaimed 4-year-old Monique, mixing red and white paint as she worked at an easel. "I discovered pink!" In this moment, Monique was the discoverer. She was the scientist. Curious about the nature of paints, she experimented and found out what would happen if two paint colors came together. She experienced the joy and excitement of creating something new.

Monique's teacher took advantage of this experience to further explore color mixing with her, including what happens when more water is added to the paint, as well as what makes colors lighter and darker.

Teachers can take advantage of the teachable moment to foster children's powers of observation, their willingness to discover and experiment, and to increase their knowledge of the scientific world. They can also achieve these things by:

* encouraging children to slow down, stop, look, and listen;
* providing experiences designed to develop children's natural, spontaneous explorations of their world into scientific investigations;
* giving children words—the tools they need to talk about and describe objects, events, and the materials in their world;
* planning ways for children to reflect on their experiences through art and music.
See Through the Eyes of Children
Take a moment in your busy day to slow down. Try to see the world through the eyes of a child. Remember, children are so young, so new to this earth. Everything is novel and wonderful to them. The role of the teacher is to take children’s wonder and build on it, helping them come to know and understand the complex and confusing world they find themselves in.

Stop, Look, and Listen!
Learning to observe, to really look and listen, is a complex process that develops as children mature. Infants observe through their senses. Toddlers roam and cruise, running their hands over everything—touching, feeling, trying to taste everything in sight. Four- and five-year-olds’ explorations are more purposeful and planned. Fours and fives notice color, size, shape, and weight. They try to find out how things work and try again until they are successful.

Hone Observation Skills
Make it a habit, both in- and out-of-doors, to refine children’s observations. When outdoors with children, ask: Which bird is singing that song? Listen. What does it sound like? How could you make the same sound with your mouth? One 3-year-old, having been asked to listen to birdsongs on walks around the school, heard crows cawing in a nearby tree. “They angry,” she said. “How do you know?” the teacher asked. “They using outdoor voices—loud, loud voices. They angry,” she explained.

Teach children to block out part of the world as they listen: Close your eyes and listen. Where is that song coming from? Give children “viewing tubes” to help them locate where the sound is coming from. Viewing tubes can be made of discarded cardboard rolls from paper towels or toilet paper. They can be covered with shiny contact paper.

Take time to look at and ponder things children find in their world. A 2-year-old picks up a rock and shows it to the teacher, saying, “Rock.” “Yes,” the teacher says. “It’s a rock. Feel it. How does it feel? Look, it’s round. What colors do you see?” The teacher then finds a small, clear plastic box and lid for the rock. The child places the rock in the box and shakes it, saying, “A rattle—now my rock is a rattle.”

One teacher kept plastic trays handy for observing. She covered small discarded trays with soft, impressive-looking velvet cloths and placed a large magnifying glass on each tray. The trays were stacked near the science table for use indoors or outdoors. Children used the trays when they wanted to observe a leaf, rock, flower, insect, or other found object. Like scientists, the 4-year-olds would examine a dragonfly’s wing found on the playground. They would talk about the colors they saw, the shape of the wing, and the dark lines that divided the wing into parts.

Encourage children to look carefully at things in their world and to consider what they see.

Ponder Over Paint and Paper
Slow down the pace indoors, as well. Paints run, flow, and drip. Clay is soft and pliable one day and dry the next. There are many varieties of paper, paints, and collage materials. But do you encourage children to stop and consider what they see? Take the time to watch as the bright, sparkling liquid paint changes into a dry, flat color on a piece of paper.

Suggest that children mix their own paints using powdered paint. Look at and feel the powder before water is added. Talk about how the powder changes as it is mixed with water. Once the paint is liquid, invite children to explore and paint with it.

Do the same with powdered clay. Feel the powder. Ask children to predict what will happen when water is added. As children gradually add water to the
powdered clay, ask them to concentrate on how the powder changes. Feel the finished clay. Mold with it. Ask children to predict how long it will take for the clay to dry.

Build Science Skills Through Art

Strengthen children's observation and scientific skills by having them observe their artwork and the artwork of others. Make a small frame of construction paper, and use it to frame parts of children's paintings and artwork. Place the frame over a part of a painting, and talk about the colors, shapes, or design within the borders. Carefully think about the words you use to talk about art. Instead of saying, “That's a lovely painting,” try describing children's artwork using scientific terms.

You can talk about lines in children's paintings and drawings. Lines can be thick or thin. They can be straight and bold. Some lines zigzag, others curve and form a shape. Describe different colors children use. Some colors—yellow, red, and blue—are primary colors. They cannot be created by mixing other colors together; but primary colors can be mixed together to create other hues. Encourage children to use their hands, eyes, and ears to explore the paper. Magnifying glasses were available to help children more fully examine the papers with their eyes.

The next day, the teacher added vocabulary and ideas, labeling papers and children's activities. “Here's a smooth piece of paper. Can you find a rough piece?” “This paper is shiny. Where is a dull piece of paper?” “Look, I can see you through this paper. You try it. This paper is transparent. That means you can see through it.” “This paper is opaque. Try to see me through it. You can't, because it's opaque.” Other words, such as thick, thin, wide, narrow, heavy, light, square, and rectangle, were introduced.

Seize the Teachable Moment

When the children's natural explorations of paper waned, the teacher challenged them to find out still more about paper. Looking for teachable moments, she asked children: “What do you see?” “What can you do with it?” “What would happen if...” “Can you do that again?” “How did you do that?”

Once children fully explored the paper, tools such as scissors, paste and glue, tape, paper clips, and staplers were added. Now the title of the table

In Colors of Learning, authors Rosemary Althouse, Margaret Johnson, and Sharon Mitchell describe how the use of discovery tables gives children the experiences and time they need to develop methods of inquiry and scientific habits of mind.

One teacher of 4-year-olds made a discovery table for paper exploration. Laying out an assortment of papers, she labeled the table Discover Paper. She showed children some of the papers—foil, tissue, tracing paper, construction paper, tag board, wrapping paper, and other craft papers—on the table. She encouraged children to use their hands, eyes, and ears to explore the paper. Magnifying glasses were available to help children more fully examine the papers with their eyes.

Try the Discovery Approach

Recognizing children's need to experiment with their world, teachers can provide them with experiences designed to develop observation skills and with the time to experiment and explore various materials.

Science Discovery Materials

Here is a list of suggested items to have on hand for spontaneous and satisfying science explorations:

- sturdy magnifying glasses
- scales—balance, kitchen, or hanging scales
- magnets
- plastic containers with lids of assorted sizes, for collecting and categorizing
- assorted sieves, sifters, and funnels
- rulers and yardsticks
- timers—old clocks, stopwatches, kitchen timers, an hourglass
- thermometers, measuring spoons and cups
- tweezers
- insect cages
- insect nets
- hand tools, trowels
- boxes, tubs, or trays for planting seeds, seedlings
- prisms
- sunglasses with variously colored lenses
- color paddles—transparent color paper, gels
- pinwheels
- a wind sock
- pulleys and wheels
- nuts and bolts
- gears and geared devices
- locks and keys
- stethoscopes
- a camera (digital or film) to capture children's discovery moments
How Young Children Explore Their World: Age by Age

<table>
<thead>
<tr>
<th>AGE</th>
<th>EXPLORATION</th>
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<tbody>
<tr>
<td>One-year-olds</td>
<td>➤ use developing senses to explore their world;</td>
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<tr>
<td></td>
<td>➤ know objects exist even when hidden, and actively search for out-of-sight objects.</td>
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<tr>
<td>Two-year-olds</td>
<td>➤ expand sensory explorations, running their hands over things, roaming and cruising in- and out-of-doors, and handling everything in reach;</td>
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<tr>
<td></td>
<td>➤ identify familiar objects by touch;</td>
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<td></td>
<td>➤ imitate the use of an object long after they observe others using the object; for instance, pouring raisins into a bowl at home after watching a teacher do so at school.</td>
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<tr>
<td>Three-year-olds</td>
<td>➤ label objects as hard or soft, large or small, heavy or light;</td>
</tr>
<tr>
<td></td>
<td>➤ begin to draw shapes of objects, circles, squares;</td>
</tr>
<tr>
<td></td>
<td>➤ still explore their world through their senses.</td>
</tr>
<tr>
<td>Four-year-olds</td>
<td>➤ attend to objects and events in more planned-out ways;</td>
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<td></td>
<td>➤ build with blocks, string beads, draw recognizable representations of objects;</td>
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<tr>
<td></td>
<td>➤ draw objects in relation to one another.</td>
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<tr>
<td>Five-year-olds</td>
<td>➤ have a wealth of conceptions about objects and how they work;</td>
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<tr>
<td></td>
<td>➤ have increasingly symbolic thought. The ability to mentally or symbolically represent objects, events, and actions is</td>
</tr>
<tr>
<td></td>
<td>accompanied by more actions that are increasingly planned and goal directed.</td>
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changed from Discover Paper to What Can You Do With Paper? After playing around a bit, children made viewing tubes, spaceships, skyscrapers, chains, and pictures. They cut paper into bits, strips, and designs.

Document New Knowledge
When children were finished with the experience of discovering paper, the teacher called a group meeting. She asked them what they found out and listed their ideas on a chart. Children said they liked specific types of paper, especially shiny paper and wrapping paper; but they also said they found out paper could be smooth, shiny, or rough. It could be bent, folded, cut, torn, cut into circles, or shaped into boxes or tubes. They ended with the statement: “You can discover a lot of things with paper.”

Make Musical Connections
Given the success of the paper discovery table, the teacher continued using discovery tables, featuring different types of crayons and markers, clay and modeling materials, and paints. Using the same idea, she created musical discovery tables. One music discovery table was a drum table. Different types of drums—metal, those made from boxes and other found objects, an African drum—and drumsticks (dowels covered with soft cloth or leather) were placed on a table. The table was called Discover Drums, and children were encouraged to experiment with the drums. Asking children to be scientists and to find out how they could make different sounds using just the drums gave them a purpose for their explorations. The teacher provided a chart near the table so children could record the loudest, softest, and sweetest-sounding drums.

Sow the Seeds of Science
Children's play with drums can be directly related to learning about the concept of vibration. Drums create sounds with vibrations. This abstract concept is beyond young children's mental maturity, yet through drum play, they can begin building the idea that vibrations are
related to sounds. A teacher might sprinkle a few seeds on the top of a drum, tap the drum, and invite children to watch what happens to the seeds. She can ask them to describe the seeds before and after she strikes the drum. She can have them tap the drum forcefully, and then gently, encouraging them to watch what happens to the seeds. It would be interesting to ask children what they have discovered about sounds. Their ideas about vibration will not be fully formed, but the teacher will have some idea of what they are thinking.

Another musical discovery table might focus on shakers. Bells sewn to elastic bands; shakers made of plastic children can use to help them talk and think about things around them.

Giving children words for their musical experiences helps children think, and expand their ideas, about music. Just knowing the word musical gives children a way to categorize their experiences with the world. Introduce the names of shakers, using the terms maraca, cymbal, tambourine, and so on. Give children the names for string instruments, listening to and naming guitars, violins, and cellos. Wind instruments, such as the trumpet and flute, can be named. Try describing the sounds instruments make.

Remember to use adverbs to describe children's movements and actions with music. Feet can make soft, shuffling sounds, or hard, punching, pounding sounds. Arms can reach high in the air or low to the ground.

Name and Label It!
Throughout the day, in- and out-of-doors, teachers can thoughtfully answer children's questions, naming and labeling everything in sight. On walks around the center or on the playground, you can: Name the plants you find. Dandelion, ivy, chickweed, and clover may be new words to children. Flowers have petals, stamens, and pollen. Look at where the leaves are found on stems. Plants have bottles filled with sand, marbles, or other objects; gourds and tambourines can be placed on a table. Banging instruments, such as triangles, blocks, horseshoes, and cymbals, can be the focus of another discovery table. Throughout, children’s attention can be focused on the vibrations that result when instruments are shaken or struck.

Make Words Tools for Learning
“What's dis? Dat?” asks the 2-year-old. Children need to know the names of things in their world. Words are tools for helping children talk about them.

Giving children words for their musical experience helps them expand their ideas about music.
Encourage Thinking and Reflecting

The scientific process is incomplete without reflection. Encourage children to think about their explorations with the materials in their world. Offering time, space, and the materials necessary for children to express their ideas and feelings helps children develop the habit of reflecting on their work.

Providing clipboards, complete with markers and paper, near the block area, out-of-doors, and in the science areas reminds children to keep a record of their experiences based on the National Science Education Standards.

Discovering Nature With Young Children Trainer's Guide, part of the Young Scientist Series, by Ingrid Chaloufou and Karen Worth (Redleaf Press, 2003), explores the elements that make up the natural world around us.

Field Trips, by Jim Arnosky (Harper & Collins, 2002), illustrates how teachers can focus children's observations of nature.


More National Science Education Standards, by the National Academy Press (1996), outlines science content.

Science Experiences for the Early Childhood Years: An Integrated Affective Approach, by Jean D. Harlan and Mary S. Rivkin (Merrill/Prentice, 2003), describes appropriate science experiences for young children.

Worms, Shadows, and Whirlpools, by Karen Worth and Sharon Grollman (Heinemann, Portsmouth, 2003), illustrates best practices based on the science standards.

Books for Children

A House for a Hermit Crab, by Eric Carle (Aladdin, 2002)
Max Found Two Sticks, by Brian Pinkney (Aladdin Library, 1997)

Soy una Oruga, by Jean Marzollo (Scholastic Inc.)
Welcome Books' How Things Grow series, by Jan Kottke (Children's Press):
From Caterpillar to Moth
From Seed to Dandelion
From Tadpole to Frog

What a Wonderful World, by George David Weiss and Bob Thiele (Atheneum, 1995)


Web Sites

Boston Museum of Science On-line
Mos.org

ERIC Clearinghouse on Science, Mathematics and Technology Eric.ed.gov
National Science Teachers Association Nsta.org/
Science Made Simple Sciencemadesimple.com

Resources

As they explore art materials, children are discovering the wonders of their world.

stems and leaves. They bud and flower. Some leaves will alternate. Others will be parallel.

Name aspects of the insect and animal life children find around them. Pigeons, doves, starlings, sparrows, and robins are nearly everywhere. Ants have heads, legs, abdomens, and thoraces.

Look at and name the symmetry of insects' bodies. If you place a piece of paper over one half of the insect, you know the covered half looks just the same, and so, children discover symmetry.

Observe antennas on insects and feelers on animals. Examine where the eyes are placed on fish, rabbits, cats, and dogs. Question why some eyes are at the front of an animal's head, while others, such as fish and rabbit's eyes, are on the sides.

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