

Integrate Science and Arts Process Skills in the Early Childhood Curriculum

How can early childhood teachers help children think creatively, discover new possibilities, and connect their ideas? Integrate science and the arts in the curriculum!

Kathy Morrison

*“The greatest scientists are also artists as well.”
—Albert Einstein*

Art and science are intrinsically linked—the essence of both fields is discovery. Artists and scientists function systematically and creatively. Their knowledge, understanding, and outcomes are explored in hands-on studios or high-tech labs. In classrooms for all ages, integrating science and the visual arts offer children the latitude to think, discover, and make connections (Alberts, 2011).

Art and science are intrinsically linked.

Scientists and artists typically observe life from somewhat different perspectives: A scientist generally takes things apart for study before bringing them together in solutions, while a visual artist interprets beauty and creatively combines media to communicate a sense of aesthetics to others.

Linking science and art explorations makes sense in early childhood education for a number of reasons.

- Young children have a natural curiosity about their world and how it works. They constantly wonder, explore, examine, describe, manipulate, compare, and question things relating to the natural environment (Eliason & Jenkins, 2008). Science concepts they encounter in their lives such as worms, snow, rolling things, and sponges are especially fascinating.

- Young children are also natural artists (Althouse, Johnson, & Mitchell, 2003). Most are delighted to participate in open-ended art activities, dramatic play, singing, and dancing. Young children paint, sculpt, sing, or dance in their own unique ways. They want to be involved in the visual and performing arts, to try new things, and to experiment with the familiar (Pinciotti, 2001).

For young children, the process in science and art is much more important than whatever product may result (Stivers & Schudel, 2008). The fundamental science process skills for early childhood are to

- observe,
- communicate,
- compare,
- measure, and
- organize (Sarquis, 2009).

Each of these fundamental science process skills can be easily integrated into all areas of the arts (visual and performing arts including music, movement, and dance) in early childhood.

Fundamental science process skills for young children

- observe
- communicate
- compare
- measure
- organize (Sarquis, 2009)

Science for young children is a process of doing and thinking, a process that anyone can participate in and contribute to, not a list of facts and information discovered by other people (Brenneman, 2009). Young children naturally use one or more of these process skills as they investigate everything that attracts their attention.

Early childhood teachers can intentionally increase children's awareness and use of these skills (Kilmer & Hofman, 1995). This article explores how science process skills can be included in a developmentally appropriate early childhood environment through the arts. It is based on the National Science Education Standards (Center for Science, 1996) as well as the National Standards for Art Education (Consortium of National Arts Education Associations, 1994).

The process in science and art is much more important than any product.

Science and Arts Process Skills

Process skill: Observe

The fundamental process skill of observing can be defined as using the senses to gather information about objects or events. High-quality early childhood classrooms contain many opportunities to observe things closely. The National Association for the Education of Young Children requirements for accreditation include that each classroom contain



Subjects & Predicates

Young children are natural artists. Most are delighted to participate in open-ended art activities, dramatic play, singing, and dancing. They want to be involved in the visual and performing arts, to try new things, and to experiment with the familiar.

a science area or discovery center for children to explore items from nature such as leaves, rocks, shells, worms; or science-based developmentally appropriate materials such as magnets and magnifiers (Copple & Bredekamp, 2003).

Good early childhood teachers provide a variety of items throughout the classroom for young children to explore with their senses. The Discovery Center may contain an ant farm constructed with the children, a fish aquarium, or a diverse collection of sea shells for opportunities for close observation. (See sidebar on page 33)

Observation skills—about living creatures such as ants, any other phenomenon, or how art media work, for example—can then be enhanced with a variety of explorations such as these learning experiences.

- After observing the ant farm, children might draw the tunnels and ants with chalk on black paper, using straight and curved lines to represent what they see. Children date their drawings and post them. Children can compare the ants' early progress with later tunnel construction, and graph the number or length of the tunnels by date.

How to Establish an Ant Farm

Materials

- One-gallon unbreakable jar with holes punched in the lid
- Soil containing an ant colony
- Shovel
- Cheesecloth
- Dark construction paper

Procedure

Use the shovel to dig up an anthill from a yard or playground. (Make sure these are not fire ants!) Include a good amount of the surrounding soil. Pour soil with the ants into the jar. Place a double layer of cheesecloth over the mouth of the jar and screw on the lid. Cover the outside of the jar with dark paper to encourage the ants to make tunnels.

Every few days, place crumbs of food in the jar and a small amount of water. Children observe the ants by sliding the paper up to reveal the ants and their tunnels (Morrison & Reader, 1986).

- Children could also glue yarn on paper to represent ant tunnels. They could follow the dry paths with their fingers, much like a maze. Where does each tunnel begin? Where does it end? Which direction do the lines curve?
- Children who paint with watercolors usually blend some colors as they paint. Ask them to describe what they see happening: “I mixed red with yellow—and now there’s orange!”
- Mix modeling dough with children (see sidebar). Write the recipe on a chart. When children follow directions and measure the ingredients, they increase their literacy and math skills. As the ingredients are combined, and food color added, children use their hands and eyes to observe how the ingredients change form. When they divide the compound into bags, they experience subtraction and division.
- Children could draw an enormous “ant farm” with sidewalk chalk outdoors. They can creep on all fours, run, and otherwise traverse the paths formed. Ants are capable of carrying up to

50 times their own weight, so provide items of varying weights for children to carry while they walk on the tunnels. Weigh the objects. How do these weights compare with the weight that ants can carry?

Experiment with art materials!

Experimentation with art materials—such as glue, paint, tissue paper, or wood—is likely to lead to a variety of discoveries about cause and effect. Many everyday early childhood experiences integrate the visual arts with the science process

skill of observing. The potential for developing science concepts is ready to be discovered and applied (Mayesky, 2009).

Observation project: Explore shadows

As part of a study on shadows, kindergarten children went outdoors to a blacktop surface on a sunny day. Children chose a partner and took a piece of colorful sidewalk chalk. They traced their shadows on the surface and wrote the time near their shadows. When children finished, they were encouraged to draw freely on another area for about 20 minutes. Children enjoyed using the chalk to make lines, trace around their shoes, design hopscotch grids, and create and color their own imaginative drawings.

After the drawings were complete, children stood at the feet of their original shadows and traced their shadows. Children soon discovered that they were drawing a new shadow...their shadows had changed! They wrote the time near their second shadow.

Children then measured their shadows to see which was longer, the first or the second shadow. This observation led to many questions about shadows, how they are made, and what makes them change. The teacher wrote down their questions and their predictions on a

Easy Modeling Compound

Materials

- Large mixing bowl
- Measuring cups
- Zipper plastic bags, sandwich size
- 5 cups flour
- 2 cups salt
- 2 cups water
- Food coloring

Procedure

Measure flour, salt, and water into mixing bowl. Mix with hands. Divide dough into bags. Add food coloring as desired. Knead gently to distribute color. Store sealed bags in the refrigerator when dough is not in use.

chart. This information helped the teacher identify more opportunities to explore shadows during the next week. Exploring shadows helps develop concepts relating to sun, light, shadows, self-awareness, and physical body characteristics (Eliason & Jenkins, 2008).

In the classroom, a light-colored sheet was hung from the ceiling like a curtain. One group of children became the audience on one side of the curtain, while the other group went on the other side, where a bright lamp was available. One child at a time stood next to the curtain. The light was used to project the child's shadow onto the curtain. The children on the other side of the curtain then tried to figure out whose shadow they were seeing. Children tried different poses to make it more difficult for their friends to identify their shadows. The groups then switched positions so that everyone had a turn to make a shadow and to identify the shadow-makers.

Children were also encouraged to include shadows in their art. Photographs and prints of art that included shadows were displayed and discussed to inspire children's creativity. Photographs are a valuable tool to help support young children's science inquiry (Eliason & Jenkins, 2008). Books about shadows were available nearby so children could look at photographs and illustrations with shadows. Black and white tempera paints were offered along with primary colors at the easel. Other media and science tools to study light—such as chalk and black paper, a prism, and plastic color-mixing blocks—were available as well.

Shadow puppets added yet another dimension to the study. Shadow puppets were used with an overhead projector to act out familiar stories in children's own words. The stories

Observing Bubble Prints

(suitable only for children who are old enough to BLOW through a straw)

Materials

- Cookie sheets or plain, light-colored trays
- Drinking straws
- Pitchers of water
- Liquid tempera, assorted colors
- Unbreakable plastic eye droppers
- Liquid dish detergent
- White construction paper

Procedure

1. Each child takes a tray and a straw. Children fill their trays half full of water. They drop liquid tempera into the water, and then add a few drops of liquid detergent. Children stir with the straw until the color is vibrant.
2. An adult demonstrates how to blow through the straw to make colored bubbles. Supervise the children as they blow bubbles.
3. When ready, children place white construction paper on top of the bubbles to make a print.

During the exploration, ask thought-provoking questions such as

- What are you doing to make bubbles? What is inside the bubble?
- What colors do you see?
- What happens to the bubbles if you blow harder (or softer)?
- What do you think will happen when you put paper on top of the bubbles?

After making the print, ask

- What do you see on the paper?
- Where are some different sizes of bubbles?
- What shapes are the bubbles?
- What happened to the bubbles when you made the print?

became more creative when children mixed characters from different stories to tell original stories.

Process skill: Communicate

Another fundamental process skill is communicating—sharing oral or written ideas and descriptions in a way that helps others understand the meaning (Sarquis, 2009). Young children constantly communicate their ideas throughout the day during whole-group activities, small-group explorations, dramatic play, storytelling, and individual projects. Every science topic opens opportunities for children to communicate

and represent concepts through the arts.

Communication project: Discover insects

Studying insects can be very interesting to young children. They observe insects found in their environment and compare their characteristics. One early childhood teacher asked each child to bring in (dead or alive) a bug in a zipper bag or unbreakable jar. Children found roaches, crickets, ladybugs, walking sticks, spiders, worms, and other creatures.

Children each described the characteristics of their bugs to the group.

Some knew the bugs' names, and some did not. With each other's help, they described what each bug looked like, how many legs it had, if it had antennae and/or wings, the color, and its size as measured with a ruler.

During the day, children took turns adding their insect to a large chart. Children noted the color, number of legs, alive or dead, and other characteristics. In the process, children became careful observers and communicated their findings in a format that others could interpret. They also referred to numerous stories and handbooks about insects to locate information about what their insects eat, where they live, and the work they do (make honey, enrich the soil).

To link the science concept skill of communicating with the arts, children painted and decorated paper headbands, masks, and vests to represent the attributes of their insects. Children wore their representations in a bug parade.

In addition, some children made detailed large-scale drawings of their insects, while others formed dough into models of various bugs, real and imaginary, and then painted them. Torn-paper collages of insects were also popular.

Children sang songs about insects, sometimes modifying the words ("When the Ants Go Marching In," "The Eensy Weensy Spider") and wrote original stories and poems about insect adventures. At the end of the project, children shared with each other and their families what they learned about their bugs. Clearly, the study of insects provides children with many opportunities to communicate their scientific findings through creative representations.

Process skill: Compare

The fundamental process skill of comparing involves examining the characteristics of objects or events to

discover similarities and differences. Young children typically notice who is taller and who is shorter, who can run faster, and which children can write their names. Teachers can notice children's comparisons as a way to help them measure attributes as well as to use and understand comparison words.

Comparison project: Pebbles, rocks, and boulders

Stones are everywhere, so children are curious about their shapes, colors, weights, and textures. For this project, 4-year-old children collected rocks in large plastic cups labeled with their names. Notes were attached to the cups asking families to help their children fill the cup. Everyone responded enthusiastically with cups full of rocks.

To prepare for the exploration, children made their own sorting mats by drawing a line to divide construction paper in half. On one side, they wrote "larger" and on the other side "smaller."

Children poured out their rocks on their mats. Immediately children began to sort their rocks and to compare their sizes, colors, shapes, and textures. Children were asked to put their bigger rocks on the "larger" side, and their little rocks on the "smaller" side.

After children completed their sorting, the teacher asked the children to count how many big rocks and little rocks they had. Children wrote the numbers in the columns on their sorting mats. Then they compared which rocks they had more of, larger or smaller. Some children realized that their biggest rocks were smaller than their friend's smallest rocks, quite an astute observation! They also compared the number of rocks each had.

Later, children sorted their rocks



Subjects & Predicates

Set up a science area or discovery center for children to explore items from nature such as leaves, rocks, shells, worms; or science materials such as magnets and magnifiers. Provide a variety of items for young children to explore with their senses.

by attributes that they chose, such as dark and light, smooth and rough, sparkly or not sparkly, shiny or dull. Some children divided the other sides of their papers for sorting by these other categories. The children looked closely at their rocks with magnifying glasses and discovered that rocks have many different characteristics.

The rocks were then added to the discovery center for further investigation. Much larger rocks, and grains of sand, were available as well. Children asked permission from friends to look at their rocks. Magnifying glasses, sorting trays, and rock identification guides were available for children's use. These are some other learning activities that engaged children's process skills:

- Seriate rock sizes from littlest to biggest.
- Talk with a father about his rock collection. Encourage children to become rock hounds, too.
- Weigh rocks on a postage scale and order them from lightest to heaviest.
- Climb on boulders on the playground.
- Identify the types of rocks that can be found locally.
- Read the book *Stone Soup* (there are several versions), write a recipe, and make soup.

To integrate the arts into the study of rocks and to provide opportunities for comparison, children were delighted to:

- Paint rocks with tempera.
- Construct rock sculptures with small stones and other natural materials. Use modeling compound and glue to hold pieces together.

- Create rock jewelry by stringing rock-like beads and beads made from modeling compound.
- Make crayon rubbings of rock textures.
- Design a rock obstacle course in the sandbox to drive miniature vehicles around.
- Write and illustrate a guide to rocks found locally. Include a map with the location of quarries or mines.

While children engaged in these explorations, the teacher asked them to compare the rocks they were using, talk about the creative process, and evaluate how well their rocks worked for the project.

At the conclusion of the study, the children's work was displayed and shared with families in an open house that included stone soup as a treat.

Process skill: Measure

Measuring is both a math and science process skill. Measuring in early childhood classrooms can be done with standard and non-standard units of measure for length, weight, and volume. For example, young children might

- use multilink cubes to measure each other
- discover how many markers long a table is
- figure out how many teddy bear counters can line up across a book
- measure ingredients to follow a recipe using teaspoons, tablespoons, and cups
- compare the weights of various items using a balance scale.

These beginning measuring activities provide children with the

opportunity to see how things are measured using a variety of units.

Standardized units of measurement—such as inches or feet, cups, or ounces—may seem abstract, but with the regular use of rulers, measuring tapes, yardsticks, scales, and kitchen utensils, young children quickly learn to measure with standard tools.

Try standard and non-standard units of measure.

Measuring project: Myself as a tool

Effective early childhood teachers offer children multiple opportunities to measure objects and even their friends using standard and non-standard units of measure including paperclips, shoes, and hands or fingers. To connect the arts to the science process skill of measuring, one group of children designed their own measuring tools using their bodies as the unit of measurement.

Pairs of children took a roll of adding machine paper. One child was asked to lie on the floor while the other child measured their friend's height with the strip of paper. Children cut or tore the paper into the appropriate length. Then they decorated their personal measuring tools with designs and images that represented themselves. Children used crayons, markers, water paints, construction paper, and other art materials. Each child's representation was unique.

When children's measuring tools were dry, they used them to measure sidewalks, tables, block constructions, and other large items indoors and out. Children recorded



Subjects & Predicates

Provide regular opportunities for young children to act out familiar stories. Read the story often, and in several different versions. Use puppets and/or flannel board figures to retell the story, so children become involved in the storytelling. While studying the life cycle of butterflies, these children wrapped themselves in scarves, like cocoons.

their measurements using paper on clipboards, and often worked together to hold the strips in place and to count the number of strips. Teachers helped children create charts on which to compare their measurements.

These creative measuring tools were eventually hung on a wall in order from tallest to shortest. Children could also weave their strips together to make a large display to demonstrate the class sense of community.

opportunities for children to organize items at school and at home:

- put blocks back on shelves by grouping shapes together
- sort dress-up clothes into different categories
- keep markers, pens, crayons, and pencils in separate bins
- line up pots and pans by size
- identify healthy foods as meat, fruits, vegetables, or dairy.

Telling or acting out a story in the correct plot sequence is an excellent way to help children focus on the science process skill of organizing through the performing arts.

**Organization project:
Perform a story**

Effective early childhood teachers provide multiple opportunities for young children to act out stories. As part of the communication process, young children organize the story plot in the correct sequence. Fairy tales such as *Three Billy Goats Gruff* or *Little Red Riding Hood* are always popular.

First, make sure that the young children become very familiar with the story. Read the story often, and in several different versions if available. Use puppets and/or flannel board figures to retell the story, so children become involved in the storytelling.

With the children, create a chart identifying major events in their order of occurrence. List the characters and talk through the sequence of the story as children prepare to act it out. Urge children to invent their own dialogue rather than trying to repeat the words exactly as they appear in the book. Be prepared to prompt young children until they become comfortable with the story. Children may also choose to create costumes and sets to retell the story—an ideal way to encourage the representation of what they have learned through the graphic arts.

A pre-K teacher at a laboratory school often provided opportunities during circle time to act out familiar stories. Children took turns playing the parts, and all who wanted to participate were given an opportunity. The children asked to “do the play” some more. They laid large hollow wooden blocks in a large square on the floor to create a stage. Some children put on dress-up clothes. Many children joined in the fun by being the audience and clapping. These “plays” were often requested by children. By reviewing the organization of the story and performing events in the correct sequence, children practiced a science process skill through the arts (Epstein & Trimis, 2002).

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Introducing science education in primary school is too late (Ozby & Alisianaoglu, 2008). Early childhood

Everyday life provides many opportunities for children to organize items.

Process skill: Organize

Organizing as a fundamental science process skill includes grouping, classifying, seriating, and sequencing. Everyday life provides many

science education enables children to refine their creativity and discover different perspectives, a strong basis for later science education. Many typical developmentally appropriate learning explorations in the arts include the basic science process skills. Integrate science and the arts into the curriculum every day.

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About the Author

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Extend

These Ideas With Books

Connect Art and Science Process Skills With a Children's Book

by Lucy Wynn



Whistle for Willie

Written and illustrated by Ezra Jack Keats.
1964. New York: Viking Press.

Peter wished he could whistle so he could call his dog, Willie. Even though he tried and tried, a whistle just wouldn't come out. Peter tried to whistle as he walked through his neighborhood, drew chalk lines, played with an empty box, and ran from his shadow. Finally, Peter discovers that he can whistle, and Willie comes running! Children will enjoy the colorful, detailed collage-like illustrations in this classic, and will identify with Peter as he does things familiar to all young children. They will especially like the ending, when Peter gets his wish.

Classroom Ideas!

While the content of this book is simple, it connects very naturally with a variety of concepts that can be integrated into the curriculum: science and math ideas, movement and music activities, and social-emotional concepts. The book can also serve as a springboard for interesting art activities.



MOVEMENT & MUSIC: In *Whistle for Willie*, Peter walks and runs, turns and jumps. Children can follow directions such as, "Everybody wearing a red shirt turn around twice." Children listen, follow verbal directions, and build a richer vocabulary. As children grow, increase the complexity of the directions: "Every girl wearing a red shirt and a ponytail jump twice and twirl around."

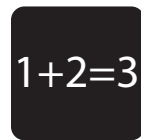


SCIENCE: Introduce science concepts about air, sound, and light and shadow. Explore a variety of penny whistles, tin whistles, dog whistles, train whistles, and whistling kettles. Children hypothesize about what makes the whistle sound, and why each whistle sounds different. Children can try to whistle themselves! Go outside to explore shadows. Experiment with flashlights and shadows indoors. Follow up with books such as Tana Hoban's *Shadows and Reflections*.



SOCIAL/EMOTIONAL SKILLS:

Trying until a goal is met, even though it is hard, is a valuable lesson for children. Talk with children about Peter's goal, and what he did to reach it. Follow up with a discussion of what children would like to learn or do, and steps needed to reach their goals.



MATH: This book lends itself to learning about length and distance, as well as spatial concepts such as long and short. What is a "long, long line"? Think about what Peter did as he walked home—he went in the box, along the crack in the sidewalk, and turned himself around. Children enjoy imitating Peter's actions.



ART: Children enjoy making cut-and-torn-paper collages similar to the art in this book. Enrich collages by adding sponge-painted textures. Trace and decorate shadows of various objects including children's own shadows.