We have all heard the wise adage about art: "It's not the product but the process." The same can be said about science. In the early childhood years, children are learning the process skills of science as they apply to different themes. The skills—observe, compare, sort and organize, predict, experiment, evaluate, and apply—are the seven essential steps to scientific thinking.

This step-by-step approach to science is flexible, allowing you to follow children's interests and discoveries. If this year children are fascinated with a rock collection a child brings to school, you may choose to use rocks and pebbles as your topic of study. But if next year a child brings in her seed collection, you might choose to focus on seeds and plants for your science curriculum. Once this process approach is in place, children will discover that they can apply it to any topic they want to investigate.

by Ellen Booth Church

photos by Lisa Brown

OUR THANKS TO THE STAFF AND CHILDREN AT CHILMARK SCHOOL IN MARtha'S VINEYARD, MASSACHUSETTS, FOR LETTING US SHOOT THE PHOTOS FOR THE COVER AND COVER STORY.
Have No Fear!
Some teachers do not feel comfortable with science. But when you approach science as a process in which you learn along with the children, there is nothing to fear. The goal in developing a successful science program is to keep an open mind and be able to see science everywhere. By providing children with many interactive experiences, you'll be teaching them how to apply the “steps to science” to everything they encounter. Follow the steps outlined here for a dynamic, interactive science program.

Using the Seven Steps “Recipe”
The basic steps for creating great science studies are similar to those in the scientific method, but expanded, with emphasis on the skills that are most relevant to young children. Let's take a look at each one:

Observe This is the process of looking closely, noticing from different viewpoints, and quietly watching and waiting without much “doing.” By their nature, children often want to jump in and “do” the experiment. We need to remind them to take the time to use all their senses when they approach an activity.

Take the observations to different levels and locales. Ask children to gather more information and viewpoints. What do you notice about these plants? What happens when you look at them from above, far away, or very, very close? Let's wait and see what happens when the wind blows them or the sunlight shifts. What do you see now?

Compare Making comparisons invites children to move beyond telling what they noticed about something and to begin expressing relationships between things. How are these plants the same and/or different? Where have you seen similar plants? Different plants? How do some plants feel different from others? What about their smell?

Sort and Organize This is the process of grouping things by recognizable traits. Children match, group, and organize materials in many different ways. They begin to understand that objects can belong to more than one group at a time. This is a great time to invite children to record their findings in pictures and graphs. Referring to these pictures and graphs, they can make further comparisons. How many ways can we sort the plants? (with and without flowers, tall and short, big leaves and little leaves) How many ways can we organize the leaves? (round, long, pointed, two-lobed, three-lobed, and so on)

Predict This is the process of questioning and speculating, based on prior knowledge gained in the first three steps. Children get better and better at prediction through experience, so be sure to provide lots of opportunities for this process skill. What will happen if we put some in a closet? Will sunlight shine through a leaf? This step also helps children generalize about things. If they notice that sunlight seems to shine through the leaves of a fern but not through a rubber plant, they may generalize that sunlight will not shine through thick leaves.

Experiment This is when children test out their predictions and try out their ideas. The key to this step is to provide plenty of different materials and TIME to explore. Provide materials for free exploration in your science area so children can visit and revisit them on their own—which is how children conduct their own version of an “independent study.” How can we test if light will shine through a leaf? How many different leaves can we test? What places can we put plants to see if they will grow? What else do you want to know about plants?
Evaluate This is where children communicate the findings of their experiments with others, taking their concrete experience, verbalizing it, and representing the information abstractly with graphs, drawings, charts, and field books. For example: On accordion-folded paper, can you make a drawing each day of the plants in your study? Use dark paper for the dark places the plants are kept and white or yellow for the light places. Which were the best places to grow plants? Which places were not good for growing plants? How many leaves could you shine light through? How many could you not shine light through? How can we show this information on a graph?

Apply This step involves applying the understandings gained from the experiment to a larger field of experience, encouraging children to broaden the scope of their experiments, try them again with new materials, and see if their understandings are consistent.

This is the time for great, open-ended questions and activities to help children think beyond the box! What would happen if the plants were covered with dark paper, light paper? Would they grow? What would they do?

Science All Around the Room
Once you arrive at the application stage, you can take the understandings and experiments outside of the science center and into other learning centers. Here are some examples of how you can take plant study all around the room:

Literacy
☐ Collect books from the library that show beautiful pictures of the natural world. All week have a special part of the earth as a centerpiece in the classroom—a flower, a pretty branch, or a bonsai tree.
☐ Tell a never-ending story. Have a large drawstring bag or
Developing Scientists—AGE by AGE
Here is a quick overview of how children approach science stage by stage.

**Three-Year-Olds may:**
* choose sensory and physical activities over problem-solving activities. Provide hands-on activities that invite them to dive into materials and be messy!
* like to do more than watch. Avoid teacher-directed and complicated science activities that require children to watch and wait.
* begin to “play with science for a purpose.” They can make a simple prediction and (with some help from you) test it out.
* have difficulty manipulating small items and science tools. Choose things such as large, unbreakable magnifiers, big bucket pan balances, and large horseshoe magnets.
* want to talk about their findings but may not have the vocabulary. Narrate their explorations—See how your puddle is smaller? It evaporated!—and model science words and language.

**Four-Year-Olds may:**
* begin to think ahead, plan, and imagine many different outcomes to an experiment.
* start to infer information gained from one experience and apply it to a new situation.
* like to use dramatic play to pretend to be scientists and to help themselves make sense of fact and fantasy.
* make simple drawings and fill in charts to record their observations and experiments.
* enjoy discussing a discovery and using new science words in context.
* take a more purposeful approach to science experiments.

**Five-Year-Olds may:**
* look at the world with more abstraction. They delight in taking their observations from the concrete to the representational level.
* follow directions (on a task card or from a teacher) for an experiment that involves many steps.
* like to look up information in books, charts, photos, and on the computer.
* enjoy telling others about their findings in a group meeting or small groups.
* be able to draw and write their findings in science journals and field books.
* feel like they “know all” about a science topic but usually have many gaps in their understanding. (But they DO enjoy filling them in!)
basket full of fruit, nuts, and seeds. Start a story with “Once upon a time, there was a happy little orange who went walking through the fields looking for his friends. When suddenly he...” Now pass the bag and continue the silly story.

Create a picture dictionary of the new science words learned and used in this unit. Add drawings and photos to illustrate each word. Place this in the literacy center to assist in children’s science journal writing.

Art
Hang a sign in the art area asking children, How can you use seeds and bulbs in an art project?
Add seed and plant paintings by great artists for inspiration at the easel.
Take away the paintbrushes and replace them with nature items at the easel. How can you paint with a leaf, a flower, pine-bough, and a corn cob?

Music
What nature objects can be used to make instruments? Bring in gourds, bean pods, coconuts, and other items for children to explore. Use these to add sound effects and orchestrate favorite songs and books!

Follow Children’s Interests
The most effective way to choose a science topic is to start with something children are interested in. Notice what they notice. In the springtime, one kindergarten class became fascinated with the rust that had developed on the outdoor play equipment. The teacher invited children to observe and notice the rust and then brainstorm what they know about it. At the next gathering, children made a companion chart of what they wanted to
Family Connections

Hold a mini science workshop in your room. Every family can be a science team if you show them these quick and easy ways to enjoy science explorations at home:

* Remind parents they don’t have to be scientists to “do” science at home. Emphasize that rather than helping their children memorize science facts, it’s more important to work with their children to find out about things together. Show them the delight of looking at the world through “scientist’s eyes.”

* Write the steps to science on a simple handout that gives parents quick ideas for using them with their children.

* Help parents see the importance of hands-on experiences. An interactive workshop or a series of one-page newsletters can give examples of science experiences that might happen in the home and highlight how to use them to their fullest. For example, show how to use prediction, experimentation, and application when studying the concept of “float and sink” with bathtub toys.

* Encourage families to support and develop the fine art of observation by taking time to watch and wait with their child. Explain how by taking quiet time to observe nature and objects, children can construct their own knowledge of how things work.

* Demonstrate open-ended questions that will invite their child to wonder, predict, experiment, and evaluate. Here are some examples: What can we do with this paper towel? What can we do with it when it’s wet? When it’s dry? When it’s wet or dry?

* Let families know the importance of sharing and learning from children. Demonstrate how their children’s interests can be used as a starting place for investigations.

* Send home children’s science studies journals with a note of explanation and suggestions for simple things they can do to expand children’s knowledge. If you are studying seeds, send home a few alfalfa seeds with directions for sprouting them and a quick idea for using them in a salad or sandwich.
find out about rust. With some containers of water and an assortment of great “junk,” children engaged in a series of experiments to find out what will rust in water and what will not. Later, they decided to test other liquids to see if the “known” rust items would rust in them as well. They wanted to know: Would a screw rust in milk, liquid soap, or soda the same way as it did in water? Certainly rust was not on the class syllabus or even a faint possibility in the teacher’s mind as a lesson plan, but by taking the lead and using the steps to science together, they created an amazing science study!

**Children’s Collections**

Children are natural collectors. Just look inside their pockets, backpacks, or cubbies and you will find the most amazing assortment of “special stuff.” You can use children’s collections as a starting place for science studies. Invite children to share their collections and discuss what they know about them. See if they have any questions about their collections that they’d like to explore. Consider the experiments, using the steps to science, that can be done with these items. Remember to start with observation and comparison. What do you notice about the items in your collection? How are the items the same and/or different? You might want to present a science tool such as a magnifier or pan balance and ask, How can we use this tool to find out more about the items in your collection? Then follow the steps to science and see where they lead! ECF

**Resources**

**BOOKS**
- *Hug a Tree and Other Things to Do Outdoors With Young Children* by Robert E. Rockwell, Elizabeth A. Sherwood, and Robert A. Williams (Gryphon House, 1990; $9.95)
- *Investigating Science With Young Children* by Rosemary Althouse (Teachers College Press, 1988; $19.95)
- *Tina’s Science Notebook* by Tina DeCloux and Roseanne Werges (Symbiosis Books, 1985; $12.95)

**PRODUCTS**
- GEMS: Great Explorations in Math and Science—25 different teacher’s guides and activity kits from the Lawrence Hall of Science at the University of California at Berkeley
  - www.lhsgems.org
  - Tree Homes:
    - www.berkeley.edu/GEMS/GEM100.html

**WEB SITES**
- Sharing Nature:
  - www.tlnfini.net/~bvandyk/nature.html
- Project Wild: www.projectwild.org/
- Exploratorium:
  - www.exploratorium.edu/ls/pathfinders/preschool/home.html

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