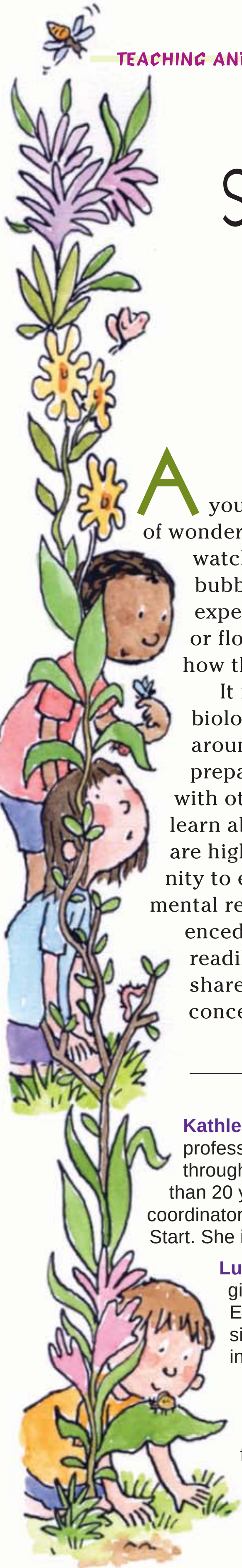

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Science in the Preschool Classroom

Capitalizing on Children's Fascination with the Everyday World to Foster Language and Literacy Development

Kathleen Conezio and Lucia French

A young child starting preschool brings a sense of wonder and curiosity about the world. Whether watching snails in an aquarium, blowing bubbles, using a flashlight to make shadows, or experimenting with objects to see what sinks or floats, the child is engaged in finding out how the world works.

It is not exaggerating to say that children are biologically prepared to learn about the world around them, just as they are biologically prepared to learn to walk and talk and interact with other people. Because they are ready to learn about the everyday world, young children are highly engaged when they have the opportunity to explore. They create strong and enduring mental representations of what they have experienced in investigating the everyday world. They readily acquire vocabulary to describe and share these mental representations and the concepts that evolve from them. Children then rely on the mental representations as the basis for further learning and for higher order intellectual skills such as problem solving, hypothesis testing, and generalizing across situations.

While a child's focus is on finding out how things in her environment work, her family and teachers may have a somewhat different goal. Research journals, education magazines, and the popular press are filled with reports about the importance of young children's development of language and literacy skills. Children's natural interests in science can be the foundation for developing these skills.

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Photos courtesy of the authors.

Back in February, Mrs. O'Shea's preschool children had explored the concept of light and shadows. They collected many types of materials to see which ones would create a shadow in the bright light and which ones the light would just pass through. After several days of experimentation, they realized that while opaque materials create shadows and transparent materials allow light to pass through easily, there are some things that don't fit either category. These materials allow some light to pass through (although not as much as window glass) and they cause very light shadows. Later in the school year, a visitor to the classroom was present during snack time when the children were trying new clear strawberry flavored Jello with stars and moon shapes in it. The visitor overheard the following conversation among the four-year-olds:

"It's transparent!" remarked one little girl with surprise.

"No, it's translucent," countered another girl.

"Why do you say it's translucent?" asked Mrs. O'Shea.

"Because you can only see through it a little," the girl responded.

Whereas many adults think of science as a discrete body of knowledge, for young children science is finding out about the everyday world that surrounds them. This is exactly what they are interested in doing, all day, every day.

In the preschool classroom or in the university research laboratory, science is an active and open-ended search for new knowledge. It involves people working together in building theories, testing those theories, and then evaluating what worked, what didn't, and why.

On a bright fall morning, a group of three-year-olds takes a walk and observes fall leaves dropping from the trees and blowing around the school yard. They come inside to read a book. The book contains a picture of a rake. Few of these urban, apartment-dwelling children have ever actually seen a rake. The teacher asks what it is and what it might be used for. A real rake is brought in as the discussion proceeds and the children speculate:

"You could scratch the grass."

"Use it for a back scratcher."

"Throw it in the garbage."

"I clean the leaves!"

All of the children's ideas are considered and a bag of fall leaves is dumped on the classroom floor. The children are given opportunities to feel the leaves, kick the leaves, and use the rake. Coming back together as a group, they reevaluate their earlier theories and decide that a rake can be very helpful in making a pile of leaves to jump into. Science, language, and literacy have all combined in a meaningful learning experience for the children.

A science-based curriculum

For the past seven years, the authors have been involved in creating, implementing, and refining a science-based preschool curriculum encompassing both content and process goals. Known as ScienceStart! this full-day, full-year curriculum is currently being field-tested at a number of sites in Rochester, New York. (Throughout, when we refer to one of "our" classrooms, we mean a classroom that is using ScienceStart! The major content goal of this curriculum is for children to develop a rich, interconnected knowledge base about the world around them. The primary process goal is to foster and support the types of typical intellectual development that characterize the preschool years. These include receptive and expressive language skills, skills in self-regulation—particularly attention regulation—and skills in problem identification, analysis, and solution. Several theoretical assumptions that are widely shared by early childhood professionals underlie these goals:

- Young children are active, self-motivated learners who learn best from personal experience rather than from decontextualized linguistic input. (e.g., French 1996; Nelson 1996).
- Young children construct knowledge through participation with others in activities that foster experimentation, problem solving, and social interaction (Gallas 1995; Chaille & Britain 1997).
- Young children should be allowed to exercise choice in the learning environment (Bredekamp & Copple 1997).
- Children's social skills develop best when they have opportunities to learn and practice them in the context of meaningful activities (e.g., Katz & McClellan 1997).

Science in our preschool classrooms is not a complicated process, nor is it an activity that occurs separately from the normal classroom routine. Almost all young children in almost all environments "do science" most of the time; they experience the world around them and develop theories about how that world works.

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At the easel, a boy may be using blue and yellow paint. Suddenly, he notices that as he paints, the color green appears. The child has the opportunity to theorize about color mixing: "Does this always happen with blue and yellow paint?" "Can I make any other colors with blue and yellow paint?"

In any preschool classroom, the process of formulating theories based on experience happens in the art, block, and dramatic play areas, and during outdoor play. The difference for the children in our classrooms is that adults work to create an environment that is integrated and coherent rather than disjointed. Thus, children explore the same phenomenon—in this case, color mixing—in different parts of the classroom, particularly in activities that involve language and literacy.

In the leaf raking example described earlier, the children took a walk outside to see leaves blowing, then read a story about leaves, then raked leaves in the classroom. They also had other opportunities that day to explore leaves. They could decorate leaf-shaped cookies with a variety of fall-colored frosting, paint tree and leaf pictures at the easel, sort real leaves by shape or color, examine leaves with a magnifying glass, and dance like leaves in the wind. Science, for all the children, was a creative and exploratory process, one in which they could use many forms of knowledge to build theories about their world. While talking with them about what they were doing, the teacher not only involved the children in a conversation, but also offered them relevant vocabulary and modeled ways of thinking about and talking about their experiences.

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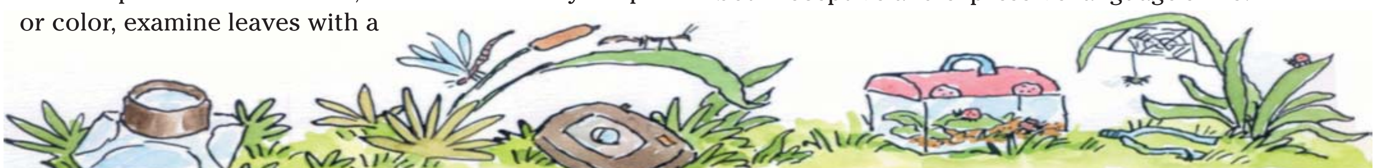
Childhood curiosity leads to real science

Many early childhood teachers are hesitant about introducing science in their classrooms, often because of their own unpleasant science education experiences. When asked if they teach science, these educators might point to the plants on the shelf or the collection of stones and shells and indicate that science is taking place "over there." Other teachers see science as some kind of magic trick to perform on a Friday afternoon when everyone is tired and bored. They bring out the baking soda and vinegar to "make a volcano." While the children may be amazed and amused by this activity, it does not build accurate knowledge and does not represent real science.

Real science begins with childhood curiosity, which leads to discovery and exploration with teachers' help and encouragement. It involves three major components: content, processes, and attitude. Young children prize information about the world around them, yet an emphasis on content is not enough. Although many people view science as a body of knowledge (facts and formulas) that scientists learn and use, in reality this body of knowledge is constantly changing as new discoveries are made. Young children, like scientists, need to practice the process skills of predicting, observing, classifying, hypothesizing, experimenting, and communicating. Like adult scientists, they need opportunities to reflect on their findings, how they reached them, and how the findings compare to their previous ideas and the ideas of others. In this way, children are encouraged to develop the attitude of a scientist—that is, curiosity and the desire to challenge theories and share new ideas. Scientific exploration presents authentic opportunities to develop and use both receptive and expressive language skills.



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In Miss Chrissie's classroom, one morning in April, an observer asked two four-year-old girls what was inside the cups on a windowsill. The girls explained that they had planted seeds and were waiting for them to grow. The observer asked how long it would take and was told, "Maybe a few days." The observer asked why it would take so long and was told, "Growing takes time. You need to be patient." The girls then explained about the plant's need for water and light. The observer looked outside and pointed out to the girls that there were grass, trees, and flowers outside that also needed water. The girls reassured her that the rain would water those plants. While this may appear to be a simple and everyday conversation (as indeed it should be), these girls were using their classroom science work to make observations and hypotheses and communicate these clearly to a classroom visitor.

The importance of a coherent approach

In *Talking Their Way into Science,* Karen Gallas (1995) explains that young children must be allowed to co-construct their knowledge about science by imagining possible worlds and then inventing, criticizing, and modifying those worlds as they participate in hands-on exploration. They must be encouraged to develop possible theories about their own questions and then proceed to investigate these theories within the classroom learning community. For this to happen, the opportunity for in-depth and long-term investigation through a variety of activities—what we term *coherence*—is essential. The girls whose seeds were growing on the windowsill had opportunities to over- and underwater plants; paint bouquets of flowers at the easel; take plants apart to investigate the roots, stems, and leaves; and make and eat a salad containing leaves, roots, stems, and flowers. They read many books about plants and participated in discussions with peers and adults about what they were learning.

Many, and perhaps most, preschool classrooms have little coherence from day to day. For example, teachers following a "letter of the week" approach may have children investigate dinosaurs one day, dig in dirt the next day, and make a dessert the third day. Each activity is developmentally appropriate and enjoyable, but other than the letter *D* they have nothing in common.

In contrast, in a coherent approach to early childhood education, each day's activities build on those of the day before and provide a basis for those of the following day. Teachers who follow a science-based curriculum find that they can maintain a focus for 8, 10, or even 12 weeks. For example, the ScienceStart! unit on color and light takes place over a 10-week period. Children explore mixing colors to make new colors, investigate light sources and how shadows are made, observe how light travels, and finally study the cycle of day and night. While each day brings new activities and new theories, the days fit together into a coherent pattern that offers children the opportunity to revisit ideas and activities, to build a knowledge base, and to use knowledge gained on one day as the foundation for the next day's exploration.

It might seem that learning about air could be difficult for four-year-olds. After all, they can't see it or even really get ahold of it. But we have found that after spending the previous eight weeks discovering the properties of solids and liquids, preschool children have a lot to say about air.

"I know it's there 'cause I can feel it in my hair."

"The bubble has my air in it!"

"Air isn't like a solid 'cause it has no shape. It's the shape of the balloon."

"You can't pour it and it doesn't make a mess on the floor."

Science at the Center of the Integrated Curriculum: Ten Benefits Noted by Head Start Teachers

1. Science responds to children's need to learn about the world around them.

2. Children's everyday experience is the foundation for science.

3. Open-ended science activities involve children at a wide range of developmental levels.

4. Hands-on science activities let teachers observe and respond to children's individual strengths and needs.

5. The scientific approach of trial and error welcomes error and interprets it as valuable information, not as failure.

6. Science strongly supports language and literacy.

- Nonfiction books become a powerful foundation for conversations with adults and peers.
- Vocabulary growth is supported by children's prior knowledge and experience of the everyday world, coupled with observation and hands-on activities.
- Receptive language (listening comprehension) is fostered as children listen to the teacher read aloud and talk about the science activity.
- Expressive language is fostered as the teacher leads children through a cycle of scientific reasoning and especially as the teacher supports the children in developing a report of their findings.

7. Science helps children with limited language to participate in the classroom and learn English.

8. The problem-solving skills of science easily generalize to social situations.

9. Science demonstrations help children become comfortable in large group conversations.

10. Science connects easily to other areas, including center-based play, math, artistic expression, and social studies.

While children's theories are seldom complete and will go through many revisions, the coherence of the curriculum offers them opportunities to make in-depth explorations over an extended period of time.

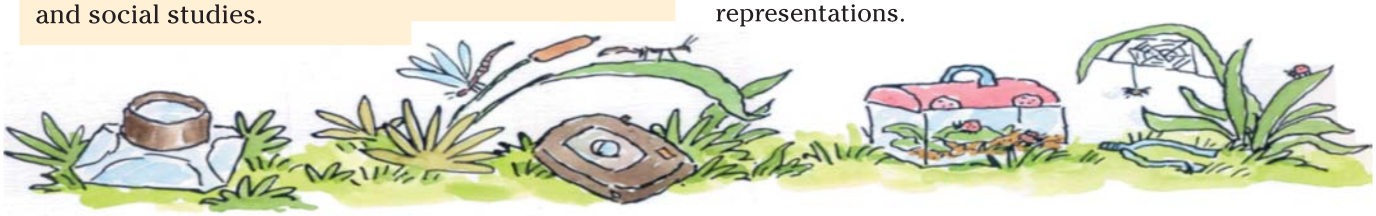
Science learning: Something to talk about

Several years ago, the local director of state-funded preschool programs was asked why she was spending money on inservice training in the area of science when, after all, "everyone knows" that language and literacy should be the focus during preschool. Agreeing that language and literacy were important goals for young children, the administrator pointed out that language and literacy learning must be *about something*.

After hearing this story, we asked our teachers, who had been using a science-based curriculum for several years, to respond to the Why science? question based on their own observations and experiences. The resulting conversation was condensed into the 10 good reasons (shown at the left in "Science at the Center of the Integrated Curriculum: Ten Benefits Noted by Head Start Teachers").

There can be many reasons for a science focus in the preschool years. Because science is so intriguing for young children, they become more engaged and therefore more attentive to and involved in the language of the classroom. A coherent, integrated curriculum allows for more complex language use and more sustained literature studies than does a disjointed approach to content.

Teachers may wonder how language and literacy experiences are integrated into a science-focused curriculum. Researchers have found that children are most likely to learn language and literacy skills when they have opportunities to use these skills in authentic situations (e.g., Goodman 1984; Teale & Sulzby 1984). The problem-solving approach associated with scientific inquiry is rich in language. Teachers can support children as they acquire and practice increasingly sophisticated language skills. The group discussion may be completed in 5 minutes or may continue as long as 45 minutes. Throughout this period, participants are involved in coherent, contingent conversation. Whether active contributors to the conversation or listeners, children gain important practice in how to maintain conversational coherence, switch and return to topics, use language to move between the past, present and future, and translate between linguistic and mental representations.



To speak, children must translate their own mental representations into linguistic output that can be shared with others. In listening, they create mental representations based on someone else's language. Translation between linguistic form and mental representation is generally difficult for young children, but in this case it is supported and facilitated by the hands-on experience being shared by the listener and speaker.

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As children were gathered around the duck egg incubator in Mrs. Toot's classroom, the teacher asked them what they knew about ducks. The children speculated about what ducks eat, and asserted that ducks quack and can swim. One girl added that they have "skin between their toes." The discussion continued about what covered their bodies, with some children arguing that it was fur, while others contended that feathers cover a duck. No agreement was reached, and the suggestion was made that they needed a real bird to look at. Mrs. Toot arranged a classroom visit from a parakeet while they waited for their duck eggs to hatch.

Investigations of the everyday world offer many opportunities for a variety of preliteracy and literacy experiences. There are opportunities for receptive and expressive language, for consulting text, and for producing graphic representations of ideas (both drawn and written). So, in our classrooms, the daily literacy activities are integrated into the science learning. As in many other preschool classrooms, our science-focused teachers read to their children every day.

Children work together to create written reports about their scientific explorations. They make graphs and charts, create books, and dramatize ideas. Many children keep science journals to record data. For example, in our classrooms three- and four-year-old children from families living in poverty used drawings and words to document the growth and changes that occurred as their caterpillars transformed into painted lady butterflies. Strong and meaningful learning takes place as children participate in language and literacy experiences about something of real significance to them.

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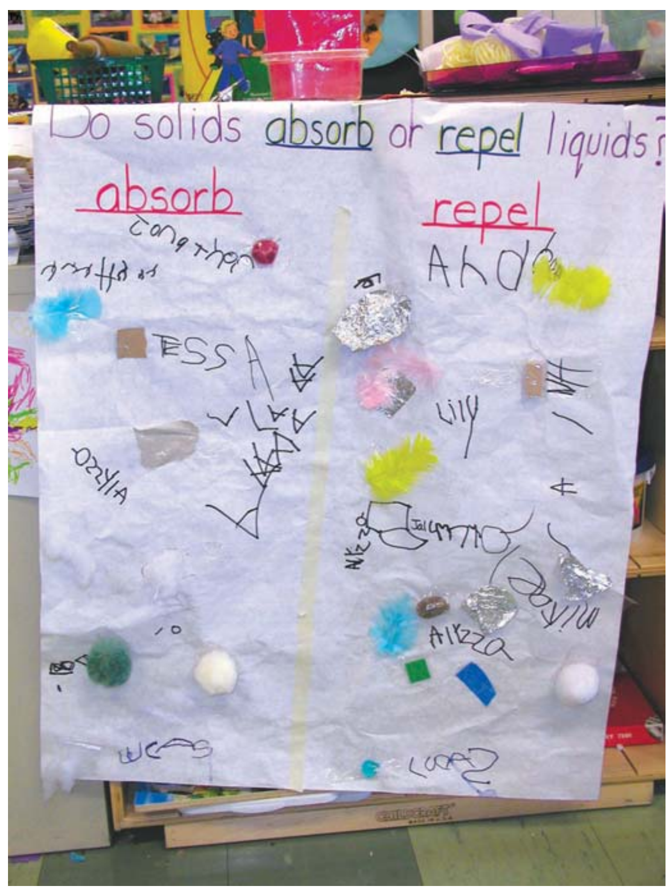
Conclusion

Some teachers want to take steps to introduce more science into their education programs, but they are unsure about what to do. These same teachers are often comfortable with cooking and art. It is possible to explore many science activities through cooking and art. A coherent unit can be developed in which the same topic is explored through three activities—science, art, and cooking. For example, the effects of air could be explored by making meringue cookies (cooking), by using a straw and hairdryer to blow a marble across a page containing wet paint to create an air picture (art), and by taking a collection of items and predicting which can be moved by blowing through a straw (science).

Teachers who increase their understanding of what science is at the preschool level will come to see that



science can be incorporated into many, if not most, of the activities that they already do. Science itself is not an activity, but an approach to doing an activity. This approach involves a process of inquiry—theorizing, hands-on investigation, and discussion.

Over the past seven years, we have worked with almost two dozen teachers who were implementing ScienceStart! predominantly with children from families with low incomes, including children with special needs. We have found consistent reactions among these teachers. They find that an emphasis on hands-on science leads to increases in children's level of engagement, in language use and language skills, and in positive peer interactions. Families have been surprised by their children's abilities to learn science and report that their children often transfer content knowledge and the process of inquiry from preschool to the home environment. For example, while in the backyard with his mother, one three-year-old asked, "What do you think will happen if we add water to this dirt? What do you think we will get?"

In 1993 the American Association for the Advancement of Science published *Benchmarks for Science Literacy,* a compendium of specific science goals for K–12 grade levels. The use of a coherent, hands-on science curriculum provides preschoolers with the opportunity to meet virtually all of the benchmarks described for children in the K–2 range. For example, at a very general level, the benchmarks for kindergarten through second grade are as follows:

> Students should be actively involved in exploring phenomena that interest them both in and out of class. These investigations should be fun and exciting, opening the door to even more things to explore. An important part of students' exploration is telling others what they see, what they think, and what it makes them wonder about. Children should have lots of time to talk about what they observe and to compare their observations with those of others. A premium should be placed on careful expression, a necessity in science, but students at this level should not be expected to come up with scientifically accurate explanations for their observations. (AAAS 1993, 10).

Most young children bring curiosity and wonder to the early childhood setting. Teachers need only capitalize on these characteristics to make science learning come alive every day. Science learning provides a rich knowledge base that will become an essential foundation for later reading comprehension. It also provides the foundation for meaningful language and literacy development.

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