Worms, Shadows, and Whirlpools

SCIENCE IN THE EARLY CHILDHOOD CLASSROOM

Karen Worth & Sharon Grollman

OF EDUCATION DEVELOPMENT CENTER, INC.

HEINEMANN
Portsmouth, NH

EDC
Newton, MA

NAEYC
Washington, DC
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CHAPTER 4

Physical Science in the Early Childhood Classroom

Physical science for young children involves direct exploration of objects, materials, and events of the nonliving world that surround children in their everyday lives. The focus of their explorations ranges from structures made of many kinds of materials, to things that move, to water and other liquids, to shadows and light, and to sounds. Physicists and advanced learners connect these phenomena by major theories (e.g., the particulate nature of matter), laws (e.g., Newton’s laws of thermodynamics), and abstract concepts (e.g., energy). But for young children, the phenomena are quite discrete and interesting and challenging to explore. The theories, laws, and abstract concepts are best left to later schooling.

Physical science often is neglected in the early childhood classroom. Teachers, unsure of themselves, often view it as too complex for them and their children. In reality, children’s exploration of objects, materials, and events goes on all the time, and physical science can become the focus of a great deal of their activity.

Doing Inquiry

Inquiry in physical science is very active. As opposed to living things, nonliving objects and materials can be acted upon. Children can manipulate them in different ways and observe what happens. They can repeat what they have done to see if the same thing happens each time. They can do simple experiments and investigations and collect data,
draw their own conclusions, ask new questions, predict, and theorize. In a classroom with carefully selected materials and the time and space to use them, children can pursue their ideas in quite independent ways in many contexts. They can use the phenomena and materials as part of their dramatic play and their games, as well as investigate what the materials can or cannot do. Physical science activity frequently involves making things and, thus, incorporates some of the skills of design technology. Children figure out how to build ramps for their rolling things, construct very tall towers, or create a flow of water from the water table to a bucket.

As in other sciences, children’s inquiry in physical science also involves documentation and representation of their work, although the emphasis is less on observational drawing and more on recording important elements such as how the funnel was connected to a tube. Many of their explorations can lead to measurement, counting, and graphing. How long is the ramp? How far will a ball roll? How much water can fit in the container? How many blocks were used to make the tallest building? Children can draw and make models of what they have constructed, whether a water system with funnels and tubes or a drum that makes very low sounds. But representation also poses challenges in physical sciences. Because the focus is often on action, recording observations such as the flow of water or a ball rolling down a ramp can be difficult. Alternative media, such as photographs, video, and audiotape, can be powerful tools to record such events.

An exciting topic generates a lot of curiosity, and in a well-designed environment, children will pursue some of their questions and try out ideas. Physical science provides many opportunities for children to try things over and over again. Designing a ramp off of which cars don’t fall can be a challenge, seeing how far a ball will roll down a ramp may need to be done more than once to be sure the measurement is right, and getting water into a baster can require serious effort. With teacher support, experiences such as these can help children develop patience, care, and persistence when things don’t work as they want them to.

Physical science is also a vehicle for fostering children’s understanding of the role of sharing, debate, and evidence. For example, when one child says her shadow puppet got bigger when she moved it closer to the screen and another says it got smaller, the teacher can encourage discussion. She can also emphasize that only through doing it again—returning to the evidence—can the children figure out what really happens.
Engaging with Content

The primary goal of physical science experiences for children is to allow them to explore objects, materials, and events in new and different ways. The more experiences they have, the more they can ask new questions and construct new theories about what is happening and how things work. Children will also raise many questions about how and why. Some questions such as “What will happen to the water if we get it to flow down this gutter?” lead to new investigations. Others may lead to simple experiments, for instance, “Which ball rolls the farthest after going down a ramp?” And still others can lead to interesting discussions or to books and other resources.

The raw materials for the study of physical science, such as water, sand, blocks, moving things, and musical instruments, are often present in the early childhood classroom. But it is the way they are used, what is added, and what is taken away that is key to the richness and breadth of children’s physical science explorations. Adding differently sized balls to the block area and removing farm animals or hanging a sheet for shadows invites investigations that focus on physical science ideas. These and other examples from the classroom stories in this chapter highlight the importance of thoughtful choices by teachers.

Busy teachers may well turn their attention to other areas of the classroom when they see children’s self-directed engagement with science materials such as blocks or water. But activity by itself is not enough: teachers need to observe children’s activity and their dialogue, and they must get a glimpse into how children think about and explain the events they see. The better they understand children’s thinking, the more opportunities they can find to extend their work and foster the development of more complex theories and understanding. They may present a challenge, help children to notice relationships or patterns of cause and effect, or encourage them to make reasoned connections between their experiences and their ideas of how and why things happen.

The content of physical science covers many aspects of the physical world. We have divided this section into three parts: Properties of Objects and Materials, Position and Motion of Objects, and Properties and Characteristics of Sound and Light. Each of the identified areas begins with a science explanation that suggests the level of understanding to be sought with young children as they explore the concepts.
Much of their thinking and understanding at this age is descriptive of things and events, but they also are eager to think about cause and effect, change, and transformation. After the description of each science area, there are notes on some of the conceptions young children are likely to hold, approaches they might take, and opportunities teachers can provide to challenge children as they encounter physical science in the classroom and in the world around them.

Properties of Objects and Materials

Developing an awareness of the physical properties of objects and materials is fundamental to later study of the properties of matter and how they change. In later grades, children will understand that under the appropriate conditions, a substance can exist in a solid, liquid, and gaseous state, and that these conditions are characteristic of the particular substance. But for young children, solids and liquids are quite different and, thus, we have divided Properties of Objects and Materials into two sections: Properties of Solids and Properties of Liquids.

Properties of Solids

Our world is full of things. Young children can be encouraged to use their senses and describe the properties of many things around them, including their color, size, shape, weight, texture, hardness, and flexibility. In some cases, they can begin to differentiate between properties that are true of the object itself (such as weight, shape, and size) and certain properties that are characteristic of the material(s) of which the object is made (such as hardness, color, or texture). Children also can use simple tools, such as a balance or a measuring stick, to measure some of the properties of objects, such as size and weight.

As children manipulate objects, they learn more about how they move, what happens when they drop, and whether they can stack one on top of the other. They may notice how some properties influence the behaviors of objects, such as how they move or what they sound like when tapped. They also can change objects, squishing a piece of clay or cutting paper into different shapes. Materials also change in
special ways when they are mixed together, heated, or simply left to change over time.

Children begin to explore objects at an early age as they hit things and grab things and put them in their mouths. Very young children may focus on one or two salient features, such as the softness of the stuffed bunny or the stripes on the ball. Some details may attract their attention and others not. As they get older, they can be encouraged to focus on multiple properties of an object.

Teachers can create many opportunities to broaden and deepen children’s awareness of the properties of objects and materials in conjunction with ongoing investigations in other areas of physical science, rather than in isolation. For example, when using different balls to explore the concept of motion, a teacher can raise questions such as “What are the differences in the balls you are rolling?” “What are the balls made of?” “Which kind of ball works best for rolling, throwing, or bouncing?” Such questions help children focus their attention on and discuss the important properties of objects and materials and some of the implications for their behaviors. In this case, children may begin to notice that some balls bounce higher or go a greater distance. By carefully describing the properties in each case, they might begin to draw conclusions and make predictions: the hard rubber balls bounce higher; the heavy billiard ball goes farther.

The exploration of life and earth science also provides many opportunities to focus on the properties of objects and materials. A study of plants might involve describing a collection of leaves; an exploration of earth materials might lead to describing the differences between the properties of sand and gravel. Children can also explore the properties and characteristics of materials in other areas of the classroom. The art area, full of collage materials, is rich in potential for discussing properties of different materials with questions such as “What is rough?” “What does tissue paper feel like?” “How strong is construction paper?” “What are pipe cleaners good for?” Similarly, cooking with children provides opportunities to talk about what they observe as they explore how ingredients change when stirred or baked.

**Properties of Liquids**

Children have experiences with many different liquids. They certainly are aware that liquids (such as shampoo, milk, and apple juice) differ
in color, thickness, and taste, and children may have some sense that all
liquids have some similar characteristics. But water is part of children’s
everyday experiences, whether they are taking a bath, drinking from a
cup, jumping in a puddle, or standing in the rain. Playing at the water
table, they can explore water and encounter some of the basic proper-
ties of a liquid: it flows and forms drops; it goes down unless made to
go up; it takes the shape of its container; some objects float in it and
some sink. Using water, children also can observe that when it is put in
a cold place, it turns into ice, and when returned to warmth, it turns
back into liquid water. It can even disappear.

Given the pervasiveness of their experiences with water, many
young children will likely have ideas about causes and effects in certain
recurring circumstances. For example, they will have floated things in
water and may believe that only light things float, not yet understand-
ing at this age the complex ideas of buoyancy and density. They may
have figured out that when it gets cold, water freezes into ice, but they
are unlikely to be able to explain how this happens. For other events
such as evaporation, they may have interesting explanations or naive
theories. For example, they may think that water disappears when left
out in a dish because the dish absorbs it, or that clothes dry on the line
because all of the water drips out, or that the water in puddles goes up
to the clouds through invisible pipes.

There are many ways to provide children with extended opportu-
nities to explore the properties and characteristics of water so that
they have more experiences from which to reason. With carefully se-
lected materials and teacher guidance, the classroom water table and
other activity centers can become places to explore the science of
water. Tubes and gutters encourage children’s investigation of flow;
containers of many sizes invite filling and emptying; small droppers
focus attention on the drops themselves; and trying to float a variety of
objects in a container of water can raise the complex issues of buoy-
ancy and density. Children’s investigations of water can also extend to
the outdoors, where children can explore concepts of earth science,
such as where puddles form after a rainstorm and how water runs
down gutters, gullies, and streams.
In the Classroom with Ms. Diego

Ms. Diego is a Head Start teacher in an urban district. Her classroom is in a public school. She has a class of seventeen four- and five-year-olds, many of whom have been in Head Start for a year already. In the story that follows, Ms. Diego describes how she facilitated an exploration of water over a period of several weeks.

Like many other teachers, Ms. Diego has a water table in her classroom that is open to the children during choice time. The children play in the water, filling and emptying containers and using it for dramatic play—to give the dolls baths, sail the toy boats, or “cook” a variety of meals. This story is about a water exploration during which Ms. Diego encouraged her children to think about some of the properties of water, how it moves, and how they could control that movement. It highlights the importance of teacher preparation through exploring the materials and learning about the science concepts. It emphasizes the important role of carefully selected materials in focusing children on the science of water. In addition, it offers examples of strategies that teachers can use to encourage children to reflect on their work.

Setting Up a Water Environment

In this first segment, Ms. Diego describes how she planned for the exploration, how she began the work with the children, and some of the “discoveries” that emerged from their work.

My children love to play with water. They love to stomp in puddles and make waves at the water table. And it seems like they could “wash their hands” for hours! I really wanted to capitalize on the children’s fascination and help them explore the science of water. After reading a bit about liquids and their properties, I removed the boats and doll dishes and the water wheel from the water table so the children would really be able to focus on water flow. Then I carefully chose some new materials—containers, tubes, basters, and funnels—and I played and explored with some at the water table myself. I attached a funnel to clear tubing and experimented with different ways to move the water up, down, and around. I manipulated the tubes in different ways, trying to figure out how to make
the water flow faster or slower, or stop altogether! Through my explorations, I was able to experience the phenomena the children would be experiencing. At the same time, my explorations really helped me to think about how I could help the children focus on how water moves and how we can affect water’s movement. I also prepared my room. I set up one water table in the classroom with a shower curtain taped to the floor underneath it, towels to catch the “drips,” and two big storage tubs in which the children could keep the new materials. My water table is small and only accommodates four children at a time. I really wanted to “saturate” the room with water play opportunities, so I got buckets and materials to make small water centers so more children could work at the same time. I hung up a clothesline for wet towels and our “water smocks” (which were kitchen bags with holes for the head and arms).

Then I prepared the kids. During a whole-group meeting, I told them they were going to be scientists. They wanted to know if that meant they were going to mix things. (Even at this young age, they have an image of a scientist as a wild chemist!) I explained that a scientist is someone who does experiments and makes discoveries, and as a class we were going to be experimenting with water and talking about our water discoveries. Then I had them close their eyes, and I put a drop of water on each child’s palm. “How does it feel?” I asked them. Susan said it was slippery. Erica said it was wet. Yvan said it was sticky (I think he must have had leftover lunch on his hand!). Pilar said it was cold. Tyler said it was warm. Colin said it was cold and then warm. Then we talked about what they knew about water.

I introduced the children to the materials they’d be using at the water table, from basters to funnels to tubes, as well as the materials at two other centers—containers of water and droppers, small funnels, and small containers.

Then I explained that they’d be taking turns at the water table and the smaller water centers each day so everyone could get a turn. We also talked about the rules from wearing smocks, to mopping up spills, to being kind and respectful to the other scientists as they made their discoveries (see Figure 4–2 on page 75).

I purposely didn’t show the children how to use the materials because I wanted them to figure out how for themselves. At first, I wasn’t sure how the children would respond to these non-“toys,” but I was pleasantly surprised at how inventive and engrossed the children were. One child, Teagan, held up a U-shaped tube and asked me, “How do I get water in it?” (See Figure 4–3 on page 75.) I turned the question right back
at her and asked, “Hmmm, how will you get water in it? What do you think you could try?” She quickly began experimenting with different techniques. First she used a big cup, filled it with water, then tried to pour it into one end of the tube, but the tube was too narrow and all the water spilled down its sides.

Then she dunked the whole tube under water, holding the base, and that didn’t work either. But she was persistent. This time she held up the U-shaped tube and used the smallest cup to pour water into one end of the tube until the water filled the U part of the tube! “Look,” I said. “There’s water in the tube! It’s not coming out.”

For several weeks, the children explored the science of water: how it flows, how to make it go in different ways (even up), and how to control

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**What We Think We Know About Water**

- You can splash in it
- You can drink water
- You can swim in it
- Everyday when it rains, I stick my tongue out
- Sharks live in water
- There’s crabs in it

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**Figure 4-1**
Rules for Water

1. Keep the water in the table.
2. Wear a smock.
3. Roll up your sleeves.
4. We can put our hands in the water.
5. No splashing.
6. Clean up the water.

Figure 4–2

Figure 4–3 “How do I get water in it?” Teagan asked.
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Figure 4-4 Dinosaur Feet Walking Through Water

Figure 4-5 “Can you feel the air come out the top?”
it. They made whirlpools, used tubes to make water pathways, and experimented with funnels.

Colin was particularly fascinated by the effect of the funnels when he pushed them straight down, large end first, into the water as if they were dinosaur feet walking through water.

He noticed that when he pulled them out, “they kind of stuck.” When I asked why that might have happened, Pilar suggested, “Maybe it’s because there is a little part that sticks out a little further and it gets caught.” Another child tried it and noticed that air came out of the small hole when he pushed the funnel down. He was excited then, saying, “Feel it, feel the air. You gotta feel the air.” I asked why they thought that might happen. When they couldn’t answer, we checked to see if there was any water inside of the funnel when it was under water, and there was. So I led them by saying, “So now water is taking up some of the space in the funnel. Where do you think the air that was in there has to go?” They all said, “Out the top!”

After about a week or so, I added some rigid tubes that could be capped at both ends so the children could continue looking at the relationship between air and water. I also added pumps so the children could explore how they could move water farther and faster.

Figure 4–6  Making Whirlpools
The kids were continually making new discoveries, and it seemed like every other minute someone was saying, “Look, I have another discovery,” or “Come see my discovery.” And each time, I headed to the water table with digital camera in hand to capture the discovery. The children then dictated what they did and what they discovered, and I attached their dictations to the photos for our class book called *Our Water Discoveries*, which we laminated and kept next to the water table.

As the children explored the water, we had weekly science talks where I invited the children to demonstrate a discovery that they made about water. Pilar demonstrated the way she added the magic ingredient to the pretend soup she’d been making at the water table. She showed us how she attached a funnel to a long piece of clear tubing, filled it with water, and moved the funnel up and down to control how much “magic ingredient” flowed into her soup. At another science talk, Brenda wanted to demonstrate the bubble she could make inside of a straight tube.
With a stopper on one end of the tube, she used a scoop to fill the tube with water. Then, she stopped the other end of the tube. She pretended she was presenting a magic trick, and she said, “As you can see, it is all full of water, right?” Then, she turned the tube around and we watched as a very smooth-looking bubble traveled up through the tube. “Whoa!” “That is so cool!” exclaimed the crowd. “What happened, Brenda?” I asked. She said that the “cap covers the very, very top.” “What is in the very, very top?” I asked. The class exclaimed, “Air!” This discussion got us going on several more demonstrations that showed us that air “always wants to be at the top.” The traveling air bubble experience was a perfect way to show that no matter which way you turn the tube (even if you hold it sideways and tip it back and forth), the air always wants to be on top. One of the other demonstrations included putting a turkey baster into the top of a tube that had water in it and watching the bubbles come to the top after we squeezed the baster.
At one point, Kris noticed something about our water pump that I had not noticed myself. He saw the red “flap” inside the pump that went “up and down when you squeeze the ball.” He tried it out to figure out when it went up and when it went down. “It goes up when you squeeze it, and then it goes down when you let go!” I asked him to explain this at a science talk. The class was absolutely glued to his demonstration. We were all huddled closely so that everyone could see the little red flap. Kris continued to explain his discovery, and I was thoroughly impressed by how well he understood the function of this contraption. He explained it better than I could have. He said, “When you squeeze the water up, it lifts up so that the water can get by, but when you are done squeezing, it goes down so that the water can’t go back down that tube. Then it comes out this tube instead!” He really got it! And so did most of the others because of his skillful explanation.
Teagan asked me an interesting question after one of these talks: “When are we going to start learning about water?” Her question took me aback since we had been doing so much water learning. I said, “Oh, but Teagan, did you know that you have already learned lots about water just by experimenting with it? Remember all of the discoveries that we talked about and all of the cool things we can make the water do now that we didn’t know about before?” She thought for a moment, then smiled.

Teagan’s question made me realize the importance of making the children’s learning visible. And as a result, I’ve started to do much more documenting of what the children are doing and learning, while sharing that documentation with the children.

At the same time, Teagan’s question made me really think about what is science in the early childhood classroom. And it’s not recitation of facts. Rather, science is about exploring and experimenting and discovering. And one more note . . . as I look back at some of these discoveries, it really hit me that the children are discovering just as much about air as about water; we’re finding that the two go hand in hand.

Many teachers worry about whether they know enough science, particularly physical science, to guide children’s inquiry. In this opening segment, Ms. Diego describes how she approached this concern by exploring water herself, using the same materials the children would use. By doing this, she was better able to focus the children’s attention on interesting events, make suggestions, and guide their discoveries. It also helped clarify the science focus of the children’s work.

Ms. Diego’s story illustrates the importance of thinking carefully about what materials to offer and when to offer them. As in many classrooms, she had a water table, and the children had engaged with it in a variety of ways, primarily related to their dramatic play. Ms. Diego’s first step was to temporarily replace the dolls and toys in the water table with flexible tubing, funnels, basters, and containers that would focus the children on the behavior of water. In this story, the children also became intrigued with air and its behavior in relation to the water, in particular, the idea that if there was air in a space, there could be no water. The rigid tubing and pumps, added later, extended this interest.

In other classrooms, the children brought other dramatic play contexts to their water play such as making magic potions or setting up a
lemonade machine. But here the play was mainly exploratory, with the focus on what the water was doing and how they could control it.

In an active science classroom, there is a great deal of interaction and talk among children and between teachers and children as they work. Teachers’ words or actions can support and guide children’s work. Ms. Diego’s response to Teagan’s “How do I get the water in

Figure 4–10 Documenting What Four-Year-Old Joana Is Learning About Water
“But when are we going to start learning about water?” Teagan wanted to know. Teagan’s question may simply have reflected her equating learning with facts. Regardless of where it came from, it raises the importance of documenting the science work. For children to build on experiences from day to day and even week to week, teachers need to make the process and discoveries of children’s work visible. Ms. Diego’s class book, Our Water Discoveries, is one way. Documentation panels that feature children’s work and ideas is another.

The Drops

The children’s work at the water table over several weeks led to interesting discoveries about the movement of water. In this next segment, Ms. Diego describes the children’s work at a water center, and how these experiences helped the children focus on the behavior of very small amounts of water—drops—what they look like, how they move, and what happens to them on different surfaces.

I set up a water center for the children to explore drops, how they are formed, and how they behave on different surfaces. I set out six trays, each with small droppers and jars of blue tinted water so the children would really be able to see the effects. I also included lots of different materials from wax paper to paper towels to dry sponges to sandpaper. During a large-group discussion, I introduced the different materials and asked the children to feel them and describe how they felt. Gabe said the sandpaper was scratchy. Amelia said the plastic plate was cool; Jeff said...
it was slippery, too. Brenda said the sponge was rough and the paper towel was fuzzy. Then I told them that over the next few weeks, they were all going to have a chance to explore drops of water and how they would “act” on each of the different materials.

Adding this new feature was a really positive step, bringing back some of the kids who started to lose interest in the water table. The drops also brought new kids on board, like Caleb. He lives with different foster families and has moved a lot. When he came into my classroom partway through the year, he didn’t talk much. He’d say things like “please” and “thank you” and “excuse me,” but that was about it. He just never got into the water table, maybe because it was just too busy.

But at the table with the droppers, he had his own space, and he had the freedom to explore without having to use his words. I’ll always remember his little squeals of delight whenever he’d make a new discovery, whether it was figuring out how to make a really big drop or how he could make drops “capture” other drops.

Figure 4–11 Caleb learns to use a dropper.
But before Caleb and the other children could discover anything about drops, they had to learn to make them! Initially, the kids just filled the droppers and then squirted out all the water at once; they just didn’t know how to create one drop at a time. So I talked aloud as I demonstrated, and encouraged the children to try to do the same.

Figure 4–12  How many drops can we fit on a plastic plate?

Figure 4–13  How many drops can we fit on a penny?
Then I said, “I wonder how many drops you can fit on a plastic plate.” First, some children tried to fill the upside-down bottom of the plastic plate.

Once they got good at this, I put some pennies on the trays. Gabe said, “Let’s see how many drops we can fit on those,” and the kids took on the challenge. (The kids were thrilled when they got fourteen drops on the surface of the penny without it overflowing.)

For a couple of weeks, the kids explored what happened when they put drops of water on different materials. The wax paper and the sponge had the most initial “draw” by far. One afternoon, Amelia and Erica were exploring putting drops on waxed paper. Amelia made the first discovery. She said, “It goes together and it stays together.”

And she was right. The water drops clung together and even combined when they were next to one another. I asked her why she thought it stayed in a clump and didn’t fall apart. She said, “ ’Cause the paper is slippery so it just slides together.” I wanted the children to compare the water’s effect on different materials, so I asked how the drops would act on the sponge. After squirting a drop of water on the sponge, Gabe said, “Hey, it’s different than the wax paper.” I asked how it was different. Amelia jumped in, saying, “The drop sunk in.” Caleb took a look and puffed out his cheeks to show that the sponge got all puffy. I asked them...
if the sponge was wet where he dropped the water. Gabe gave me this look, like “of course.” “How about the waxed paper? Can you move the water drop so that we could feel if it made the paper wet?” He used the dropper to blow air on the drop and, sure enough, it moved to another spot. It was a very cool discovery to find that the paper didn’t really feel wet!

Madison watched with fascination as her water drops spread throughout the paper towel.

She exclaimed with drama, “It goes, and goes, and goes, and goes!” Brenda, who was watching Caleb put drops on paper towels, explained, “It soaks in.” I asked them why they thought it didn’t soak into the plastic. They thought it had something to do with the plastic being slippery and the paper towel being soft. Madison also noticed that she could “spread out the bubble more on the sand paper because it’s stickier” (unlike the wax paper or plastic plate). Gabe noticed that the drops on the wax paper “were the most still,” while the drops on the paper towels were “the most spreadiest.”

We had regular science talks during the time that the drop exploration was available. The children who had been working at the drop

Figure 4–15 Madison, Age Five, Observing How Drops Spread on a Paper Towel
table shared what they had learned about drops through their explorations and conversations. I was quite impressed by the words they used to describe what they had seen: spreadiest is my favorite so far! What a concrete and understandable way to describe most absorbent! During our final discussion, I brought one of the trays to the science talk and asked the children to share some of their ideas about why they thought the drops behaved as they did on wax paper, paper towel, and sand paper. Gabe, Caleb, Madison, and several other children all came up with ideas that had to do with the nature of the surface—its slipperiness, stickiness, roughness, etc.

I am continually struck by how the children can identify cause and effect and provide some beginning causal explanations that I used to think were out of their reach. With lots of experience and interactions with others, they can describe how things act, whether it’s how a pump works, or how to lift a funnel attached to a tube full of water, or how drops behave on different surfaces.

Providing children with opportunities to explore water in multiple ways allows them to experience many different yet related characteristics and behaviors of water. Providing multiple contexts also allows different children to approach the material in their own way. For Caleb, the quiet, individual exploration allowed him to engage with the water in a safer way.

As in Ms. Howard’s story about using a magnifier to look closely at living things, Ms. Diego also took time to help the children learn to use a tool, in this case, the dropper. Many of the children might have figured out how to use the dropper on their own, but by providing specific activities, she helped them practice controlling the dropper so that they could focus on the drops themselves.

This segment emphasizes the importance of teachers’ interactions with children to guide them to go deeper. After Gabe had had the opportunity to explore drops on his own, Ms. Diego decided to pick up on his observation about the drop on the wax paper and ask him why he thought this was happening. Noting that he was thinking about the relationship between the surface and the drop’s behavior, she suggested that he compare the behavior on wax paper with the behavior on paper towel. This brought others in the small group into the activity and included them in the reflection on the results. It also encouraged the children to describe what they were seeing and doing, building a
descriptive vocabulary with words such as *stickiness*, *roughness*, and the wonderful *spreadiest*.

Once again, in this segment, a large-group science talk gently pushed the children to go beyond observation and description to come up with ideas or theories about what they observed. In this case, they were beginning to see the relationship between the nature of the different surfaces and the shape and behavior of the drops of water.

**Position and Motion of Objects**

Young children are intrigued with how things move, how to make them move, what makes them move, and when they move. Through their experiences, they are beginning to build an understanding that inanimate objects do not move on their own; they need to be pushed, pulled, or dropped to get started or to change the way they move. People can do the pushing and pulling, motors and engines can make things go, and things move when they are dropped or on a hill. Movement can be prevented as well. Barriers will keep a ball from going down a ramp, balanced blocks will keep a building from falling down, and a rough surface can stop a toy car from rolling. As they investigate, children can describe where things are and how they move and trace the movement of an object from one place to another. They also can move things in different ways and see that this movement depends on factors such as the kind of push or pull on the object, the shape of the object, the materials of which the object is made, and the kind of surface on which the object is moving.

As children explore movement, they also are building experiences about the force of gravity. They see that some things move by falling or sliding down a tipped surface. Different objects slide or roll differently on different surfaces at different angles. A structure will not stand unless carefully built with attention to balance and stability.

Fascination with motion begins at an early age. One of the first games a toddler plays is dropping something over the edge of a crib or high chair so that the adult nearby will pick it up. Other childhood games involve pushing, pulling, throwing toys, or building towers of blocks and knocking them down. Children also notice movement in their everyday lives when leaves blow in the wind, balloons float in the
air, and cars drive by. From their experiences, they are likely to construct interesting theories about why and how things move.

There are many opportunities during the day for teachers to build on children’s interest and focus their attention on motion. Outdoor play involves many things the children can move, such as balls, wagons, tricycles, and swings. A block corner that is stocked with ramplike materials such as long thin unit blocks, strips of heavy cardboard, and pieces of pipe insulation, along with many things that roll, can invite children to explore movement. A well-equipped block corner also allows children to experience the challenges of building structures that will not fall down and to notice what strategies seem important for building tall or wide.

Motorized and windup toys can add a level of complexity to children’s explorations of motion, and discussions about what is making them move can extend children’s discussion of animate and inanimate objects. The science of how things move through air is complex, but children can make and use kites, streamers, gliders, and parachutes. They can describe what happens, try out different designs, and think about the relationships among the movement of the object and its size, its shape, and the materials that make it up.

The following stories illustrate how two teachers used their blocks and a wide array of materials for explorations of the ideas of position and motion of objects. Ms. Chin’s story focuses on ramps and rolling things; Mr. Jacobson’s focuses on building structures. Like the water table, a block area is a common feature of most classrooms. It is a place where young children engage in a great deal of sociodramatic play and, through their play, become familiar with how the basic materials behave and “work.” The two teachers used different strategies to focus the children on the science of the block area. In Ms. Chin’s classroom, the introduction of the ramps provided the children with exciting challenges that replaced the dramatic play for the time being. In Mr. Jacobson’s classroom, much of the work on structures was integrated into the children’s dramatic themes.
Ms. Chin is a teacher in an urban day care center. Her class is made up of sixteen children: half of them are three years old, the other half are four, and many are now in their second year in her classroom. She is fortunate to have quite a large space in the basement of a local church and, thus, has space for a large block area. This is very important to her, as she believes strongly that blocks have a central role in the early childhood environment and that children need both space and time to build and explore. In this segment, she describes how she used the blocks to help the children explore the behavior of different kinds of rolling things on many kinds of ramps.

Starting with Threes

My kids had done a lot of block building. They built roads for their cars and trucks to drive on, towers for their guys to fall off of—and it was the story that drove the play. I wanted to see if the children would respond to a change of focus to the movement of things on ramps. So one afternoon I brought a bunch of hollow wooden blocks outside along with some planks and several cars and trucks for some of my three-year-olds to explore. Jared announced, “I’m gonna make a tunnel.” Initially, that wasn’t my agenda (ramps were on my mind, not tunnels!), but Jared was so excited I went with it. Then at one point, with ramps still in mind, I said, “How about a road that goes down into the tunnel?” Frankie picked it up and laid a ramp flat on the ground next to the tunnel. “What do you think would happen if we put the truck on it?” I asked. Jared put the truck on the plank, and we all watched to see what would happen. “But I want it to move!” Jared said. He pushed it along the ramp and it stopped halfway to the tunnel. Then Mike lifted the plank so the truck rolled into the tunnel. “Can you fix the road so the truck goes into the tunnel, even if Mike isn’t here to hold it up?” I asked. Frankie leaned the plank against a big waffle block. He put the other end next to the tunnel. When Mike put the truck on the plank, it sped down into the tunnel. The children squealed with delight: “Wow, that was fast. It went really far.” “Wow, you guys made a ramp!” I said. “Now I’m wondering if you can make a ramp that will make the truck go so fast that it will speed ALL the
way through your tunnel.” Quickly the children went to work, meeting a number of obstacles.

I watched as the children experimented, offering comments if I noticed them getting too frustrated. I’d say things like, “I’m noticing that this is the spot that makes the trucks bounce off”—just enough information to help them move along in their problem solving. I wanted them to do this on their own as much as possible, but I didn’t want to lose the focus on motion.

Dramatic play is often the context for children’s work with blocks. Their focus is on building something that serves as the stage for enacting scenarios of many kinds. But with the focus on the dramatic play, children are less likely to pay attention to the challenges they are encountering as they build and are unlikely to want to stop and think about them. By taking a few blocks, ramps, and trucks outdoors, Ms. Chin created a mini-environment in which she thought the children would be more likely to explore how the trucks moved on the ramps. Jared’s interest in tunnels was easily incorporated into Ms. Chin’s goal.

One might ask whether Ms. Chin’s intervention when the children were building the ramp was the right moment to intervene or not. Allowing children to struggle with something and to try different ways of making something work are important parts of science inquiry. But Ms. Chin wanted the focus for the children at that moment to be on
the truck’s motion on the ramp, not on the building of the ramp. By offering a few comments, Ms. Chin helped the children solve their problem more quickly. Had she wanted the focus to be more on building structures, she might have let them work on this problem for a longer time.

Steepness and Distance

The three-year-olds’ work with ramps sparked an interest with the other children as well. In this segment of the story, Ms. Chin selects some new materials for the block area that are likely to engage the children in a more complex use of ramps and to lead to thinking about the relationships between the characteristics of the ramps they build and the motion of rolling objects.

A number of the other children saw the work of the little group of threes and started to make structures with ramps using the little cars and trucks. After a week or so, I wanted the whole class to have a chance to explore motion on ramps and different materials for making ramp systems. My goal was to focus the children’s attention on the systems and how they could combine materials to make balls (and their cars and trucks, too) move in different ways, at different speeds, and along different pathways. I played with the trucks, balls, and ramps myself to get a sense for the possibilities and to review and clarify some of my own understanding. Then during one of our morning meetings, I showed the children some cardboard cylinders from wrapping paper (about four feet long) and long cardboard “gutters” (four feet by five inches) that I made by splitting a few of the cylinders. What I liked about the gutters was that the kids would have to figure out how to arrange them so they could control the balls and get them to go from one to the next without hitting a dead end. I also put out a bucket of balls. Next, I asked, “What do you think we could do with these materials?” One child said, “Make things for rolling balls down.” “Yeah, let’s do that,” the other children piped in. I then posed a challenge—I asked if they could work together to build a system that would make the ball travel all the way across the room. So many children were interested in working on the challenge that we decided to form four groups of four children each to work together.

It was interesting to see how different children interacted with the materials and how they worked together. For the three-year-olds, it was mostly trial and error. They’d place the blocks one right next to the other.
Worms, Shadows, and Whirlpools

Figure 4–17 Building Ramps for Balls

Figure 4–18 How far can my ball go?
not really noticing if a ball or truck would go through. Then, they’d roll the truck down the ramp, and if it hit a “stuck point,” one of the kids would try rotating the block and they’d try and try again. It was different with the four-year-olds. With them, it wasn’t just about trial and error. There was goal setting and planning and problem solving, and it was a collaborative process. They weren’t just sharing materials; they were sharing ideas, and one idea would feed into another idea. They were always talking to each other—setting goals, identifying obstacles, and suggesting solutions: “We need to make the tunnel really, really long.” “But the balls are flying off the sides.” “We need to build up the sides.” “No, let’s use the gutter.” “How about we tape it so it won’t slip?” “Tape it to the rug so the balls won’t fall down anymore.” “And

Figure 4–19a Drawings by the Ramp Kids, Ages Four and Five
put some blocks under the ramp to make it stronger.” At one point, two groups worked together to create an enclosure with ramps coming from different sides, leading into long tubes. “Cool,” shouted the children as the speeding ball disappeared into one of the long tubes and flew out the end. “It works! It works very fast. It works faster!”

I was thrilled by the children’s constructions and their excitement about getting the ball to go through the tunnel, but I still wanted to focus their attention on how far the different balls would roll and what they thought caused any differences. So the next day I gave the “ramp kids” sheets of round stickers that they could stick to the carpet where the balls stopped so that they could explore how the height of the ramp and its steepness affected how far the ball would roll. I articulated the new chal-
challenge: “How far can you make the different balls go using the same ramp?” Not only were the stickers a source of motivation, but they also invited the children to collect data so that they’d have evidence about when balls go the farthest. I helped the little group design and use a chart to record their data. It had three columns. One had the name of the person who made the ramp; the next had the number of blocks holding up the ramp (one child just drew them). We used a yardstick and Unifix® cubes to measure the distance and wrote that down in the third column. The group couldn’t have done this alone, but I really think the chart helped them think about what made a ball go farther.

We looked at the stickers on the floor and at the chart, wondering why sometimes the ball went really far, and sometimes it didn’t. Fiona
said she made her ramp really high and her ball went really far. Jared said, “I did it this way,” and he used his arm to show how he angled his plank. “How many blocks steep?” I asked. I helped him find his name on the chart. “Three,” he said. Brendan had another idea. He had become a leader in the class since we started doing balls and ramps, and kids looked to him for solutions and to spark new ideas. Brendan said, “I made my ramp like a mountain. And if it’s really steep, it makes the ball go really far and really fast, too.” Then he had an idea for a new challenge. Could we hold the plank so that a ball would go down it really fast, then go up another plank?

Introducing new materials led to more complex and challenging work. The new kinds of ramps—tunnels and gutters—allowed the children to extend their roadways, and they also posed new design problems as they tried to keep the balls going. Some children created their own challenges with the new materials, as Brendan did when he suggested holding the plank so the ball would go down then up another plank. And Ms. Chin created challenges to help the children think about the relationship between the steepness of the ramp and how far the ball would go.
Simple open-ended materials such as those used in this and other stories can be used in many ways and at many different levels of complexity depending on the age, challenges, strengths, and interests of a particular individual or group. In this case, the same materials were used by the threes to “try and try again” and the older fours to set up an experiment and collect and analyze data.

Ms. Chin encouraged a small group of children to collect and record data. The stickers on the rug provided a record of how far the balls went but not the relationship to how steep the ramp was. Both the chart and the measurement itself were challenging for this group of older fours, but it provided an opportunity for them to think about the evidence and come to the conclusion that “really steep” matters.
Marble Runs

In this last segment of Ms. Chin’s story, she provides the children with an opportunity to extend the focus on how balls move on ramps by adding a new set of materials.

Whenever I give my children opportunities to compare materials, they learn more about each! So after the kids had been exploring balls and ramps for a few weeks, I wanted to give them a chance to use what they had learned, but with different materials. So I put out all different kinds of marble machines. There were the already-made machines, and the younger kids loved to just drop marbles in and watch them roll from one chute to another. Sometimes I’d say, “I wonder what would happen if we put something in besides the marble,” and the kids would put in small beads, roundish pieces of plasticene; one child tried a grape. A few tried objects that would go nowhere—a tiny block and a paper clip. Then we’d compare how the different objects moved and think about why the marble moved faster than the grape or plasticene and even the beads. And

Figure 4–20a  Marble Machine by Matthew, Age Four
we’d talk about why the paper clips and blocks went nowhere. The children decided that the “good rollers” were all really round and really smooth.

I also borrowed Duplo® sets so the children could make their own marble machines. What was so neat was that while the kids were building

Figure 4–20b  Marble Machine by Erin, Age Four
their marble machines, some of them were making connections to what they had done before. It’s not so much that they talked about their learning. Rather, I could see them using what they had learned. They’d say things like, “Let’s make this really, really high so the marble goes really, really fast,” and “We gotta make it steep too so the marble really pops up!” “We need something to catch them if they get away.” The marble machine also reinforced what they learned in a visible way—that if the incline is really steep, the marbles can just fly.

Their discoveries and explorations didn’t end in the classroom. At one point, I took a variety of balls and small blocks and other things outside, and a group of us worked at the slide in the playground. I asked them to find a really slow slider or a fast one and predict what would happen when we let go of it at the top of the slide. We talked about why they thought some things slid faster and slower. “It’s because it’s bumpy.” “It’s not slippery.” “It will go really fast because it has wheels.” “It’ll get stuck because it’s so heavy.”

Then we sent different balls down the slide. I reminded them what we had done in the classroom and what we had learned about how far balls would go. Most remembered that when they made the steep ramp, the balls really went far. This time the ramp—the slide—couldn’t be changed, so we focused on the balls themselves. “The soccer one will go the farthest.” “No, it’ll bounce.” “I bet that little golf ball will win.” “It’ll be the superball, because it always goes far.”

Marble machines are a common toy in early childhood classrooms and quite intriguing to many children. The younger ones enjoy watching and listening to the marbles run down the ramps. Older children also find them interesting, and often engage more when they can control the ramps. In this segment, Ms. Chin used the marble machines as a way to extend the work on ramps and rolling things by focusing on marble machines of many kinds. Highlighting them at this stage, after the children had explored with the more open-ended materials, meant that the children could bring to this experience a different level of thought and could construct new ideas about the way different objects move on ramps of different steepness, length, and material. Their comments suggest this is happening. The playground experience, using a variety of balls, extended the exploration even further.
In the Classroom with Mr. Jacobson

Mr. Jacobson is a teacher in a Head Start classroom in a small town. He has twenty children, ages four and five. He has always had a lively block area used by groups of children for a good part of the day all year long. In the story that follows, he describes how he reshaped the work in the block area over a period of several months to focus the children’s attention on building itself, including the science concepts of stability and balance of forces, designs that make buildings stand up (or keep them from falling down), and the properties of different types of building materials.

Getting Started

Before we started our exploration of structures, I wanted to create an environment that set the stage for building. First, I took lots of photos of our school, capturing different details of the building, from the shapes of windows to the pattern of the brick walls. I also wanted to get the kids thinking about building, so I asked them to draw pictures of structures they’d want to build. Janine drew a picture of a castle. Manny drew a picture of a fort. Rico and Ben drew a picture together of a tower. Then as a group, we looked at all the materials in the block area and talked about what the perfect building space would look like and the kind of materials they’d want to add. They had lots of ideas. Ben said, “We need hard hats.” Rachel said, “Nails. Screws.” Becky said, “Oh, yeah sunglasses, in case it gets too sunny.” Rico said, “And we need more space for our building.”

So I got to work, expanding the size of the block area, carefully organizing the unit blocks and cardboard blocks and pieces of recycled foam so the children could easily access them and put them away. The Duplos® were put in the closet for safekeeping. To start with, I wanted the exploration to be about balance and stability and did not want any building materials available that stuck together. Hard hats and goggles were added to encourage dramatic play (and for safety), and there was a supply of different-sized paper and markers for representation. I put the pictures I had taken of our school building on the back wall of the block area.
area, along with posters of all different kinds of structures from barns to castles to high rises. I thought the children’s work would be less restricted if they worked in smaller groups so I decided to have no more than five in the area at one time. I also wanted to provide opportunities for more children in my class to build, so I created building centers around the room with small-scale building materials like cubes, small unit blocks, and KAPLA® blocks.

It’s not that the children hadn’t been into building all along. Even before we began the unit, the block area was one of the most popular areas in the classroom. But really focusing on the building itself was an adjustment for me and for the kids. Before, the children played in the block area independently. Practically the only times I’d get involved was when “fires” needed to be put out or when a child needed help engaging in the play of others.

This was going to be different. If I was to encourage a focus on the science of building, I had to learn how to be a part of the children’s building explorations. At first, just setting aside time to be with them in the block area was a struggle. And it took awhile for me to feel OK with just sitting in the block area and watching. It’s like, wait a minute. What am

Figure 4–21  Building with Small Unit Blocks
I doing? I’m not teaching. And what if the director walked in? It might look like I’m just taking a break, but it’s so much more than that. While I was watching, I was paying attention to what the kids were doing and what they were exploring. Just “being there” was important for me and for the kids, too, helping them to realize the value that I placed on their work. But I also had to learn how to push their thinking without interfering with their plans. And their plans were driven by their dramatic play. Whether they were building with unit blocks or paper cups, their goal was not to figure out how to build a complex structure. Rather, their goal was to create a fort for their “guys” to hide in or a garage for their cars to park in. I tried asking a lot of questions like, “What do you think you could do to make this wall stronger or your building taller?” But they often didn’t want to have anything to do with my questions; they were too intent on their play, so they just ignored me.

Our group meetings were really important in helping us transition into the science of blocks. Sometimes I’d introduce different kinds of blocks at a meeting, and we talked about them—whether they were hard or soft, their size and shape, what they could do with them. For instance, when I brought the foam blocks to the meeting, the children compared them with the other building materials they had used. They talked about how they were lighter than the wooden blocks, and they weren’t as slippery, so they were easier to balance. And when I introduced the idea of building a strong structure, we experimented with the blocks as a group, thinking about how to make a structure tall but also strong enough to stay up.

The children then experimented with these ideas during choice time, and I spent time in the block area or at the building centers, observing what the children were doing and talking to them about the building decisions they made. Having talked about the actual building at meeting time, the children were more likely to want to talk about how they were building. I remember the time that Anna and Janine were building an intricate castle that stretched the length of the table. Anna was quite intent on balancing the rounded side of a half circle on the very top of her circle. Janine was quite sure that it wouldn’t work and tried to convince Anna to “try a flatter shape.” Anna persisted and, with careful adjustments, was successful. As their castle took shape, I asked them questions about the purpose of various sections of the castle, but mostly about why they chose the shapes and placements of the blocks. I watched both girls as they carefully adjusted and readjusted the placements of the support blocks. “This will make it not as tippy,” Janine said. “Yeah, and we can
put more on top!” Anna added. I asked, “Why couldn’t you put more on top before you fixed these bottom blocks?” Janine responded, “Because it would crash, and we’ve worked very hard on our castle. Will you take a picture now?”

I had told the children I would take a picture when they felt they had done something important that needed to be saved. The pictures often became a part of a group discussion about building and sometimes became a bridge from one day to the next, helping the children to build on and extend their work.

This story highlights the role of the physical environment in children’s science exploration. Here there is a large space for building with big blocks combined with multiple places for small-scale building to take place. There are photographs and pictures of familiar and unfamiliar structures, and tools and materials for representing structures in different ways. The materials available also play a large role in focusing attention on the key science ideas of stability and balance, as well as the relationship between the properties of the blocks and what they are good for. Materials, such as Duplos®, that stick together reduce the focus on balance and equilibrium. Foam blocks, with a very different surface texture and weight, increase the likelihood that children will think about how the properties of building materials matter when

Figure 4–22 Anna and Janine’s Castle
building. KAPLAS® (small rectangular blocks, 4¼ inches by ¾ inch by ¼ inch) encourage a focus on design alone, without the added variable of multiple shapes.

Blocks and the block area are often places where children work on their own or in groups. Busy teachers are content to leave them be. An important part of what Mr. Jacobson did here was to become part of the building environment. As he described, it is not always an easy transition for teachers, from simply overseeing the block area to deciding on specific goals and becoming directly involved in the children’s explorations. As he does so, Mr. Jacobson communicates the importance of their work, encourages and probes their thinking, all the while learning from what they do.

Photographs play an important role in this story. By taking pictures of structures in the neighborhood and putting them up in the block area, Mr. Jacobson encouraged the children to keep in mind the connections between their work and the larger world of structures outside the classroom. In most settings, buildings cannot be left up for long. By taking pictures of the children’s buildings, there was a permanent record: something to talk about, to go back to, and to compare with new work.

**Enclosures**

Once the children had spent some time building with the materials that were available in a variety of ways and talking about their work, Mr. Jacobson decided to focus more specifically on one kind of structure—enclosures. He hoped this would focus the children’s attention on the challenges of building strong walls and corners, as well as floors and roofs:

When looking over the photos of different structures that some of the children had built, as well as at my notes, I realized that most of their structures were enclosures of some sort—buildings with walls and roofs (see Figure 4–23 on page 108). At the same time, I realized that through their many experiences, the children were beginning to build stronger and taller enclosures. I wanted to take it further, to help the children explore characteristics of various building materials and how different building designs affect how tall and how wide they can build.

I had just read the class a story about woodland animals that make a home inside a little boy’s mitten. Since the kids loved the book, I decided
to use the story to spin the idea of enclosures. I said, “The animals in the book needed a home that would keep them warm and safe.” Then I showed the children our special Share Bear and said that she needed a home inside our classroom, and our job was to build her one.

So, with a collection of blocks at hand, we discussed how we might build a home for Share Bear. To get the conversation started, I asked them to remind me what they knew about building strong houses. Then, we began building as a group. Anna was concerned, though. What if the walls fell in on Share Bear? We talked about the need to make really strong walls to protect Share Bear. Jeff said we should lay the blocks flat on top of each other, then added, “Share Bear will be warmer that way.” I asked him why. He answered, “Because the wall is thicker.”

Then I asked what else we had to think about. Amaya said that Share Bear needed to have space, but would he fit? We constructed a cave for Share Bear, but Robin said that if he stood up, he would bump his head. I asked what he would bump his head on (we hadn’t made a roof yet) and the children said, “Hey, he needs a roof so he doesn’t get snowy!” So we used the long wooden blocks to make a roof and talked about how far apart the walls needed to be for the roof block to be secure. Share Bear got bopped on the head a few times in the process of

Figure 4–23 A Four-Year-Old Making Strong Walls
moving the walls around, but the cave was strong, and complete with a snowproof roof.

As we wrapped up the discussion, I said that we had made a great cave for Share Bear, but there were lots of other ways to build caves (see Figure 4–25 on page 110). Some children predicted that the foam blocks would be better for a cave because they were softer. Others said they could build a bigger cave so Share Bear could have more space inside. Then I invited the children to create their own caves for Share Bear in the block areas during activity time.

Since this discussion, the block area and the building centers around the room have been hot with cave building. The children have built caves with cardboard blocks, making lots of inside space so if Share Bear jumped, he wouldn’t hit his head on the roof.

I asked one group using unit blocks about a roof. Some of the walls were tippy so I asked them what might happen if they put a roof on top of tippy blocks. So they aligned the blocks in the walls and placed the big wooden blocks across the top. Jeff surveyed the roof and wondered, “But what if the blocks fall? Share Bear will get hurt.” They finally settled on

![Figure 4–24 Robin, Age Four, Building a Cave for Share Bear](image-url)
using a big book for the roof, but they put a couple of square units on top of the book. “Why did you do that?” I wondered aloud. “So it doesn’t blow off!” they answered.

Other children played out entire scenarios around the cave. Jeff and Yvon lined up an army of small dinosaurs that were heading Share Bear’s way, saying, “Quick! The dinosaurs are coming! We have to finish before they come to eat him! Toot toot! That means they are getting closer! Hurry!” Working together, they timed it just right so that Share Bear had a slippery rock (arch-shaped block) below his cave so that when the dinosaurs arrived, they couldn’t get up to Share Bear.

At first, the small blocks were not as popular, until one child created a miniature cave for a small plastic bear. My next challenge for them was to make a cave big enough for Share Bear out of small blocks! Because they would have to use a lot more blocks for the walls, they would have to think more about how the little blocks were stacked in the walls and how thick they needed to be to support a roof.
This story about Share Bear illustrates how teachers can bring in science ideas while supporting and encouraging children’s dramatic play. Particularly with building activities, children are likely to focus their work in dramatic contexts. They are less likely to build just to build; more likely they are building something specific for some purpose. In this case, the need for a cave for Share Bear provided a class context that worked and a task that was bound to lead to new building challenges. To meet the challenge, the children had to focus specifically on building strong walls that would support a roof. This led Jeff to decide to lay the blocks on their sides, and when he and Yvon were protecting against dinosaurs, to align them carefully. The focus on enclosure meant the children also had to think about how walls came together, how to create corners of some sort, and what to do about a roof. The materials of the roof had to be strong enough not to sag, but could not be so heavy that the walls were in danger. The many versions of caves using different materials and, eventually, different-sized bears provided opportunities to compare and contrast building materials, design, and scale.
Not all the children took on the challenge of building caves for Share Bear, although they did participate in science talks and small-group discussions, commenting on the work of others and sharing ideas of what Share Bear did or did not need. Some of the children were more into building towers, so that became the next challenge, exploring how to build them tall and strong at the same time. In this case, the construction itself was the context.

Before choice time, I simply said, “Some of you may want to see how tall you can make your buildings,” and suddenly a group of children started building wildly tall skyscrapers.

As they built taller, some of them started comparing the sizes of their different towers, and we were into math. Elijah proudly announced, “My skyscraper is the biggest.” I asked, “How do you know?” He said, “See, I used a lot of blocks!” Together, we counted twelve blocks. Then I said, “Amanda’s tower looks pretty big, though.” This prompted Amanda to count the number of the blocks in her tower. “I have eight,” she said. Elijah said, “So mine is bigger!” “Can you draw pictures of your towers,” I
Figure 4–28a  Drawing of Building by Jessica, Age Four

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When Ena counted all the squares in the tower, she counted 21 squares.

Figure 4-28b Drawing of Building by Ena, Age Five
Figure 4–29  A Model of a Tower with Many Windows, by Lynne, Age Four
asked them, “so we can remember how big they are?” The kids then drew pictures, showing how many blocks they used in their towers. A couple of children used materials in the art center to make a model.

I tried to help them consider not only the number of blocks, but also the materials they used. I said, “Well, let’s look more closely at the blocks you used.” Together, we talked about the fact that Elijah used unit blocks and Amanda used cardboard blocks. “Are the blocks the same size?” I asked them. After comparing the unit blocks with the cardboard blocks, they concluded that the cardboard blocks were fatter. I probed some

Figure 4–30
more: “So how do you think we can figure out which tower is taller?” Amanda stood next to her tower and used her hand to show that it came up to her nose. “Do mine now,” said Elijah. Amanda stood next to Elijah’s tower and used her hand to show that it came up to her mouth. “Mine is littler,” Elijah said, looking a bit disappointed. I posed a challenge then, asking, “Do you think you could work together to make Elijah’s tower even taller?” and they took off. For forty-five minutes straight, they worked together, trying to figure out how to make the tower taller and taller without it falling down.

Once the excitement of measuring the towers subsided, I wanted to focus in on what the children did to make their towers stable and strong. In the block area, I asked them about how they made the towers so tall. What was important to do? What would make their towers stronger? How could they make them bigger? I used the pictures that I took of their buildings and their own words to create a documentation panel about what they had learned about making tall towers. This panel became the
focus of our group discussion and then went up in the block area (see Figure 4–31 on page 117).

The challenge certainly worked to motivate some of the children, but after a couple of weeks, I wanted to get beyond building the tallest towers, so I decided it was time for a trip. It took a good week to organize, but the whole class took a bus trip to see a number of different towers in our town—several church steeples, a clock tower, a tall skinny building downtown, a house that had a turret on the top, and several more. For the trip, I brought a video camera and I got a bunch of disposable cameras and let each child take three pictures of parts of towers that interested them.
After our trip, the children drew pictures of the towers they saw. They looked back at the photos they had taken and they looked at the videotape, too, to help them remember how tall the towers were and their different features—where there were arches, which buildings were more narrow at the top, how the bell tower was constructed.

The children began incorporating details of the towers into their own buildings. At the same time, they were really focusing on the structural aspects of building. They said things like, “Oh, I need to put a beam here because that’ll keep it up,” or “I need to lay the blocks this way to make it really strong.”

Figure 4–32b Elijah’s Drawing of Thompson Hall

The structure was so, so tall! It had pointy roofs on the tippy top. I saw so many double doors but I was too tired to draw all of them.

By Elijah, 4/5/01

Thompson Hall
Challenges such as this one can be a way to focus children on a very specific task and set of ideas. Setting the challenge of the tallest tower encouraged many of the children in the class to really struggle with how to build up and which blocks to use and how to stack them to make a stable tower that could keep going higher.

Comparing the towers helped the children consider how to describe the height of their structures. When the number of blocks didn’t work, they had to find a different strategy—actual measurement. This example is one of many where mathematics, the language of science, is an integral part of children’s work.

Figure 4–32c  Amanda’s Drawing of Thompson Hall

I loved seeing the weather vane on the top of the tallest part of the tower. When the wind blew it moved in circles and told me about the weather. The clock was so huge in the tower. It was bigger than me. The structure was made of bricks and stones and other stuff too. Bricks and stones are strong, probably that’s why they built it like that.

By Amanda, 4/5/01.
Specific challenges can become narrow and sometimes competitive when children focus only on making their tower taller than anyone else’s. The trip to look at towers provided the motivation for the builders to make their towers more complicated by adding details that they noticed on the real buildings. Trips for specific purposes can also help children connect their ideas to the world outside the classroom.

The Architect

There are many connections between children’s science exploration and the work of adults around them. Mr. Jacobson was fortunate to have an architect willing to come into the classroom.

Figure 4–33  “I need to lay the blocks this way to make it really strong.”
I was talking to my assistant teacher about the children's structures—what they were building and the challenges they were facing. That's when she said she had a good friend, Phil, who was an architect; maybe he could talk to our class. I thought it was a terrific idea to bring someone in who could help the kids think about the steps people take to “dream a house,” then turn it into a reality. And the timing seemed right. After all, they had been building for weeks. They were ready for a new experience.

That night I called Phil, the architect, and we came up with a plan for his visit. He'd ask the children for ideas for the perfect house. Then he'd use their ideas and his drawing tools to make a blueprint. We talked about what tools he'd be using—a square, a compass. Before his visit I bought a couple of examples of each tool to give the children a chance to touch them and play with them before Phil came in. The day before the visit, I brought the kids together in a circle and told them that we were

Figure 4–34
going to have a guest visitor who was an architect. Then I explained that architects draw blueprints—pictures of structures so that builders know how to build them.

When Phil arrived he showed the children a blueprint. Then he told the children that they were going to make their own blueprint of their dream house, but first they had to come up with some ideas about the different parts of the house and what each would look like. There were lots of ideas. Abby wanted a house with a balcony. Elijah wanted a skyscraper. Asa wanted a castle.

Phil kept honing in on the specifics, asking the kids what parts of those buildings they wanted. He sketched on the chalkboard, incorporating features that the children had requested, like Abby’s balcony and Asa’s castlelike arches. Meanwhile, he kept pressing for more details. “Should we have windows? What kind? What shape should they be? Should they go up and down or should they swing open? How many doors should we have?”

Phil used the children’s ideas to refine his sketch, and believe me, my kids didn’t hold back from providing Phil with feedback each step of the way. They’d say, “No the tower should be taller. You need an arch. Make a pillar. The window has to be bigger and round on top.” As the children provided feedback, Phil erased different parts, then tried to capture the details the children wanted.

When the sketch finally passed muster, Phil began to transform the sketch into a blueprint, talking through the process each step of the way. He said things like, “I’m going to use the drawing compass to make the arch. . . . Now I’m using the square to make the windows that swing open. . . . Remember, I’ve been using these tools for a long time, and it takes practice. So just be patient when you’re using your tools.”

Because my group already had experiences building, they were able to share some of their own ideas and questions with Phil. Amanda described the building process she used, and some of the problems she experienced. She told Phil, “It was hard to build a really tall skyscraper because it would fall a lot.” Phil asked, “What did you do to make it stop falling?” Amanda didn’t take long to answer, “I found big fat blocks. I put them on the bottom. They’re strong.” Asa tried really hard to explain at what point his building would just collapse; he just couldn’t find the words. But he didn’t give up. Instead he grabbed a bunch of blocks so he could demonstrate. Phil and the kids started experimenting then. They built on soft surfaces, then on hard surfaces, and they talked about which surfaces provided a better foundation and why. They also experimented with
different types of blocks and talked about why the bigger, wider blocks on the bottom helped to balance the structure on top. Phil was with us for an hour. I never would have predicted that the group would stay engaged for so long. But except for a few of the younger ones, they were with him the whole time.

Before Phil’s visit, none of the children ever thought about drawing their plans—they just built. But things changed. We added a new step to our building process: making blueprints. That was important because I really wanted the children to think through what they wanted to build, what it would look like, and what features it would have. To encourage the children to draw blueprints, I put a table next to the block area with paper and drawing tools so they always had access to them. Not all the children were able or interested in doing this, but most gave it a try.

Figure 4–35 Making a Blueprint, James and Charles, Age Four
Young children’s work is usually immediate, each step guided by what came before. When working with materials such as blocks, their approach is often characterized by trial and error, and it is often difficult to plan. But in this story, the children had done a lot of building, had drawn their buildings, and had talked about how they were built. Phil’s visit provided the children with the motivation, support, and tools to become planners. In this way, the children were developing a very important inquiry skill.

Bringing in community people or experts can enrich children’s experiences and extend their work. It also connects what children do to people outside the classroom walls. Finding the right expert, one who can share his or her ideas in ways that are accessible to young children, is critical. Bringing in the experts also requires preparation, of the expert as well as the children. In this case, the children’s work building structures meant they had thought about some of the problems and ways they wanted to build things. Mr. Jacobson also had discussions with the children about the visit beforehand, helping them to connect their work with that of an architect, while giving them the opportunity to use the tools he would bring.
Figure 4–37 These are windows and here I am. Valentina, age three and a half.
Figure 4–38a Gabi used architect tools to make his blueprint.
Properties and Characteristics of Sound and Light

In the world of physical science, light and sound are related: both are forms of energy. However, for young children, light and sound are familiar but are very different phenomena. Understanding light and sound is for later years, but exploring light and shadows, making and describing sounds, and seeking out cause-and-effect relationships are appropriate and exciting inquiries for young children.

Sound

From their daily experiences with sound, children know that different sounds have different properties. They can be loud or soft (volume) and high or low (pitch). As they explore sounds, children can identify certain sounds and come to realize that the kind of sound depends on what is making it. In some cases they can see or feel the thing that is making the sound (for instance, the string on the guitar) move back
and forth, preparing them for understanding the role of vibration in making sounds.

Sounds are everywhere in children’s lives. Children hear sounds from many sources and make many sounds themselves. They sing, speak, yell, and laugh. They make sounds for their toy animals and the front loader; they bang the lids of pots together and experiment with the piano, guitar, or other instruments that are available. But many sounds around them are disconnected visibly from their sources. Music comes from CDs and television and is often part of the early childhood classroom; the sounds of air-conditioning and heating and plumbing systems are steady background noise; traffic noises become a blur undistinguishable from the sounds of individual cars. To develop a deeper and broader experience with sound, children need many opportunities to make and explore sounds, their sources, and their characteristics.

As children study sound, they can listen carefully and try to describe the sounds they hear and what is making them. For example, they can listen for sounds in the neighborhood and try to find their source; teachers can make tapes of mystery sounds for the children to describe and identify; or with teacher guidance, children can create a “band” with homemade instruments. Children may notice the movement of a drumhead, string, or rubber band when it is plucked or hit, but that is not the primary focus of their exploration. Rather, the principal focus is the type of sound that different objects make and how children can control the volume and sometimes the pitch. Guided discussion can help children describe sound and develop ideas about the relationship between the nature of the sound and the object that is making it.

Light

Children have no lack of experiences with light and dark, and they know that light allows them to see things. Through new experiences, they can focus on different sources of light and how light can be brighter or dimmer depending on its source and how far away it is. They can begin to realize that light can make shadows and that shadows change size and shape depending on the location of the object and the light source.

At a young age, children are still likely to believe that the objects they can see contain their own light sources. Many believe that their
own shadows are somehow separate from them, following them about in sometimes scary ways. Varied experiences indoors and outdoors with light and shadow will develop the experiential foundation for later learning of more abstract concepts of light as energy, how it travels, and how it is absorbed, reflected, or refracted.

Exploring light and shadows helps children develop new awareness and ideas about light. For example, children can draw their shadows on the sidewalk during the day and see changes. Flashlights in a dimly lit room can encourage children to think about the relationship between the light source and where in the room they see the light. Putting colored gels in front of a light source or looking through them makes the world turn red or blue. A light source, interesting objects, and a simple screen provide opportunities for children to notice that position and distance matter when they are trying to make a shadow of an object.

In the Classroom with Ms. Tomas

The story that follows is about shadows. Ms. Tomas describes a part of the study of shadows she did with her eighteen children, ranging in age from three to five. Ms. Tomas’ day care center offers a sliding fee and most of the children are dropped off by family members who work in the office building next door. Ms. Tomas noticed that her children were intrigued with shadows. But she knew that for the children to explore some of the science of shadows, they would need more opportunities to work with shadows in different ways. In the following segments, Ms. Tomas helps her children think about what a shadow is and the relationship between the object, the way it is held, and the shadow it casts. She also provides the children with opportunities to think about how a shadow changes when it is moved closer to or farther from a light, and what happens when the light itself moves.

Starting Outdoors: A Teachable Moment

We had created our own garden right outside our backdoor. It was Colin who first started noticing the shadows because we had talked about the
garden needing sunlight. We were outside in the early afternoon and we
could actually see a crisp line gradually crawl over the garden. “Look, a
shadow,” he said, pointing. I said, “Wow, you’re right.” Then I asked the
children, “What do you think a shadow is anyway?” They had lots of
ideas. Louisa said, “Everyone can see their shadow” (Louisa).

It follows you (Ben).

The sunlight makes it happen because it’s so bright (Costanza).

Shadow go away in the night (Lei-Anne).

Sometimes you see shadows in the night (Jeff).

Figure 4–39

garden needing sunlight. We were outside in the early afternoon and we
could actually see a crisp line gradually crawl over the garden. “Look, a
shadow,” he said, pointing. I said, “Wow, you’re right.” Then I asked the
children, “What do you think a shadow is anyway?” They had lots of
ideas. Louisa said, “Everyone can see their shadow.” Ben said, “It follows
you.” Costanza said, “The sunlight makes it happen because it’s so
bright.” Lei-Anne said, “Shadows go away in the night,” but Jeff dis-
agreed. He said, “Uh-uh—sometimes you can see them.” I wrote down
their ideas and hung them up in the classroom, so we could revisit them
later.

The next time we were outdoors, a group of children started playing
with their shadows, running away from them, jumping, waving their
arms to see the shadows wave. For a number of children, making castles
and birthday cakes in the sandbox was replaced by shadow play—seeing how many times they could step on each other’s shadow or have their shadows touch hands (without the kids actually touching hands). Some discovered that they could make monster shadows, too, with four legs and four arms and antenna. Initially, the younger ones, in particular, seemed to be convinced that their shadows were always there—that they were really a part of them. But seeing their shadows actually disappear when they ran into the shade made them wonder.

Given their interest, I decided that we would explore shadows more deeply, focusing on how shadows change and what makes them change. On a sunny day, I traced several children’s shadows on big poster paper at different times throughout the day—almost like we were making a human sundial. A few of the older ones were able to trace each other’s. At the end of the day, I encouraged them to compare how their body tracings were alike and how they were different. “There’s my head and my hands and my feet,” said Costanza, pointing to the different parts of her body on all the shadow tracings. “And does your shadow change?” I asked. Karen studied the progression of her shadow tracings. “This one is big,” she said, pointing to her morning shadow. “This one is more lit-tler,” she said, pointing to her lunchtime shadow. “And now I’m big again,” she said pointing to her afternoon shadow. “Oh,” I said, “so it’s the size that changes.” Over the next week or so, this group and others would come up and say, “Ms. Tomas, let’s go out and see our lunchtime shadow.” “I want to go measure my after-lunch shadow.” Many of the children began to realize that the size of their shadows changed, depending on the time of the day.

This study of shadows emerged from a “teachable moment,” demonstrating the reality that children are surrounded by interesting science phenomena that may spark their interest at any time. Sometimes teachers’ responses to a child’s interest may be an encouraging word, a discussion, or support for the child in some ongoing activity. But sometimes, as in this case, teachers make the decision that there is something valuable to be explored more deeply by the whole class. Given children’s interest in shadows, and the fact that they can be explored in a number of ways, Ms. Tomas chose shadows as a focus—to help the children think about what shadows are, how they change, and what makes them change.

There are many shadow activities that can engage young children. Ms. Tomas decided to first trace the children’s shadows to emphasize
that shadows change. As the children compared their shadows at different times of the day, it was clear to some that they had changed in size, which provided a springboard for talking and thinking about what was different and what might have caused the change.

**Moving Shadows Indoors: Shadow Theater**

The next step in Ms. Tomas’ exploration of shadows was to focus the children on ways they could manipulate the shadows and make them change. The outdoor work had roused their interest and would certainly continue on sunny days, but she felt a more controlled environment indoors would allow them to take their experience further and begin to see some of the relationships between how light is blocked and the shadow that is produced.

I have a wonderful book called *Shadow Night* by Kay Chorao. It’s a story about a little boy who is afraid of the monsters that he sees in the nighttime shadows. His parents comfort him, while showing him he can make his own shadows as well. I hung a sheet in front of the window so the children could make upright shadows with their bodies and see how they could make them change (see Figure 4–40 on page 134).

In the meantime, I was thinking about where to go next and how to extend the children’s investigation of shadows even further. I wanted them to really focus on making different shapes with shadows and how to make shadows bigger and smaller. The “post office” in our dramatic play corner that I had made from a huge, sturdy cardboard box was transformed into our very own shadow theater! The first thing I did was stretch a screen of lightweight fabric across the opening of the box (where the post office clerks once stood). Then I placed a light in the back of our theater.

During our morning meeting, I introduced the shadow theater. I told the children that they had already learned a lot about shadows by exploring them outside and with the sheet. They would now have a chance to learn even more by exploring shadows with real lights. “This is our new shadow theater,” I said. “What do you think we can do with it?” I asked. Andrew said, “Make spiders!” “What else?” I asked. “Make a fat goose,” said Costanza. “So you can make animals,” I said. “Also look at this.” I had borrowed shadow puppets from the classroom next door—they were beautiful, with bright colors on parchment paper, and my assistant teacher and I put on a little puppet show. The kids were so excited.
They said things like: “You’re making shadows.” “Indoor shadows.” “Shadow puppets.” “Shadow plays.” After our shadow play, I told the children that soon they could make their own shadow plays too, with puppets, their bodies, or just their hands. *Shadow Night* actually includes pictures showing how to hold your fingers just right to make different animals, from spiders to elephants to alligators to dogs to geese. I showed them the pictures and said I had copied some and would hang them up in the theater where they could see them and try them out.

For weeks, the kids explored shadows in different ways. I was very excited because I had not previously worked with a group that became so engaged. Some children were into making shadows with their entire bodies. As they stood close to the screen, their shadows became clear and dis-
tinct. Leaning backward, shadows grew big and fuzzy. “Look it’s growing!” shouted a child as she stretched her body high.

A friend stood wiggling his hand to cast a shadow. “A spider! It looks like a spider. My hand made a spider!” Quickly hands were twisted and shaped to create the images of recognizable animals. The children also began to recognize the silhouettes of friends: “I can tell that’s Ben back there. His hair is curly.” One child ran to her cubby, grabbed her winter hat, and stepped into the theater. Before her grew a shadow with two tassels perched on the top of her head. Meanwhile another child quietly formed shapes on the screen, softly talking to herself. When she was done she looked up at me and cheerfully said, “I just told a haunted hand story!”

Other children made their own puppets by pasting together colorful fabrics and paper samples to make simple cardboard body shapes. At first, the “puppet children” focused on their own puppets. Moving high and low on the screen, a child would say, “I can make it hop really high. Oops, it crashed!” Then the puppets began moving across the screen and, eventually, the puppets began to talk with one another. And the audience was delighted to discover that the colors of the puppets showed

Figure 4–41a Shadow Puppet Plays
through the screen. “Look, that one sparkles!” commented a child who was watching a puppet decorated with glossy purple paper.

The children definitely noticed the changes that were happening—shadows getting bigger or smaller or skinnier—but I wanted to help them share their thinking about how to change the shapes and sizes of shadows. So one afternoon, after they had been exploring shadows for a few weeks, I brought the whole group together around the shadow theater. “Time for today’s shadow show,” I told them. The children took turns making different shadows. Willie made a shadow goose. Costanza made an alligator. Ben made a monster. Then I asked them what they needed to do to make their shadows big. Andrew got up and walked away from the screen. “Can the rest of you show me?” I asked, and all the shadow kids moved farther away to make their creatures big. “Can you make them even bigger—into giants?” I asked. The children took giant steps backward. I asked them, “So what do you need to do to make your shadows small?” The children yelled out, “Move closer.” The shadow kids moved close to the screen to make their shadows small. “Now can you make your shadows skinny?” The shadow kids experimented then, moving their hands up and down. Then Andrew turned his “monster hand” sideways and his monster shadow got skinny. “It’s skinny,” the audience called out. “You made it skinny.” “How did you make it skinny?”

Figure 4-41b  Shadow Puppet Plays
Figure 4–41c  Shadow Puppet Plays

Figure 4–41d  Shadow Puppet Plays

Physical Science in the Early Childhood Classroom
I asked. “Gotta turn it like this,” Andrew said, demonstrating. “Oh,” I said. “So you have to turn him sideways.” As I recorded the children’s ideas about how they could make their shadows big or small or skinny, it struck me that the children were really beginning to see the connections between cause and effect!

The study of shadows is not dependent on lots of materials or equipment, but does require a light source and a “screen” for the shadows. Ms. Tomas’ first setup with the sheet and the natural light from the window helped the children transition their shadow play from outside to inside. The children could still use their whole bodies to make shadows, but now could see them in front of them rather than on the ground. The puppet theater, smaller and with an actual lamp, provided the opportunity and the motivation for the children to use smaller objects they had made, as well as their hands and parts of their bodies. The sharper shadows created by the lamps also encouraged more detailed work and a focus on what shadows each object would make. They also explored the relationship between an object’s location and its shadow’s size.

Figure 4–41e  *Shadow Puppet Plays*

I asked. “Gotta turn it like this,” Andrew said, demonstrating. “Oh,” I said. “So you have to turn him sideways.” As I recorded the children’s ideas about how they could make their shadows big or small or skinny, it struck me that the children were really beginning to see the connections between cause and effect!
The use of both the sheet and the screen introduced the idea of theater or performance with an audience on the other side. Clearly, this provided the children with a playful context in which to create shadows and make them move and change. By spending weeks playing with hand shadows and puppets, the children had become very familiar with shadows. But Ms. Tomas realized that familiarity may not lead to deeper understanding. She, therefore, engaged the children in conversations and demonstrations focused on how to control the size and shape of the shadows by moving the objects. She also encouraged the children to theorize and test their theories. Not only did these conversations extend the children’s thinking, they also provided Ms. Tomas with new insights into the children’s thinking.

**Shadow Corner: Opaque and Transparent**

As the interest in shadows continued, Ms. Tomas decided to set up one more center where the children could explore shadows in another way. The overhead projector offered the opportunity to focus in on what one could and could not learn about an object from a shadow. As the story suggests, another concept emerged as the children were working: light can show through some objects!

Because the kids were so into shadows, I decided to set up a “shadow corner.” There, I put an overhead projector on a table, shining it on a big pull-down screen. The four-year-olds were into making shadows. At first, they would stand in front of the screen, making shadows with their bodies and with their puppets. Then, Costanza put her puppet on top of the overhead and was surprised when she didn’t see much on the paper screen. “Hey, I lost my shadow. What happened to my shadow?” (The puppet was big and covered much of the overhead screen. However, the image that shined on the screen was fuzzy.) “Let’s try something else,” said Andrew. So they put the puppets on the floor and tried putting plastic shapes on the overhead. This turned into a game of “guess what I’m putting on the overhead.” A few of the three-year-olds in the class joined in and sat between the overhead projector and the pull-down screen. They were entranced as they watched the screen and tried to figure out what was making the shadow. “It’s a donut!” “It’s a lion!” “A T-rex!”

I noticed what was going on and talked with the group about their observations and about which things were easier than others to guess. A couple kids figured that the flatter the thing was, the easier it was to
guess—like a puzzle piece or one of the flannel board shapes. But the pencil was easy, too, and it was round. I encouraged the children to draw pictures, showing what their shadows looked like on the overhead. I was amazed when the kids described their drawings, pointing out where the light came from.

The next day a child said, “Ms. Tomas, you gotta see this.” One of the children had put a color paddle on the projector and there on the screen was the red paddle. “It’s colored.” I asked why they thought this made a colored shadow and the puzzle pieces didn’t. I suggested they look for other things they thought might let the color through. This led to a lot of trial and error using different-colored things in the classroom. I didn’t want them to get discouraged, so I offered one child our colored translucent counters. It worked and they were thrilled, trying them all out and seeing the colored disks on the screen. Then there were the soda bottles that one child brought in and some colored cellophane from someone else.

After this had gone on for a few days, I decided to get the children who had been part of this together to talk about what they had discovered. A couple of threes listened in, but I’m not sure how much they took away. The older ones were quite intrigued by the color. “Some things make a black shadow.” “They’re dark.” “You can’t see any color.” “The colored things are shinier.” “They look neat.” At one point I felt that they would understand when I said that some light was shining through the objects and that when that happened we called the thing “translucent.” Then I said that when the shadow was all black, there was no light shining and we called that “opaque.” I didn’t care whether they remembered the words but thought that a few might enjoy using them. After that discussion, a few of the children continued to look for things that would have a colored shadow.

The children in this class had played with the shadows created by the sun outdoors, those made on a sheet from the daylight coming in the window, and those created with a strong light source in their shadow puppet theater. The overhead projector was yet another way to create shadows that were sharp and crisp, and thus focused on the actual outline of objects. By engaging with shadows in a variety of ways, the children were able to build on their experiences, make connections between them, and develop new ideas.

The colored projections from the overhead took a group of children in an unplanned direction. Ms. Tomas’ original focus was not on
color or how much light went through the object. But given the children’s interest, she followed up. She also had certainly not set out to teach the children the vocabulary words translucent and opaque. Direct teaching of vocabulary in science can leave children with words for which they have little underlying understanding, but modeling “big words” as children explore and describe the thing or event is important, and some children will enjoy using them.

**Summing Up**

The basic tasks of teaching science are described in Chapter One. But, just as in the life sciences, there are specific strategies that are particularly important for the study of physical science topics. Thinking back over the stories of Ms. Diego, Ms. Chin, Mr. Jacobson, and Ms. Tomas, the following are important similarities in how they planned, guided, and facilitated the children’s explorations.

- All of the teachers chose a focus for inquiry and had specific concepts and ideas they wanted the children to experience and think about.
- Each teacher spent some time working with the materials themselves so they would have a better understanding of what might happen and how to support and guide the children in their work.
- In each of the stories, these teachers carefully constructed a physical environment that supported inquiry into the selected topic. This included a redesign of the working space to allow a good number of children to work in different spaces at the same time and to provide easy access to necessary materials.
- The teachers paid careful attention to the materials they made available. They added materials that would focus the children on the selected concepts and temporarily removed those that supported other kinds of work and play.
- All of the stories are about the exploration of materials that are also very conducive to sociodramatic play. There are many
descriptions of how these teachers observed and acknowledged this play, while creating a science focus.

- Each teacher provided the children with opportunities to explore the topic in a variety of different ways, using different materials and working in different settings.

- In each story, there was a mix of open exploration, guided investigation, and challenges, which provided opportunities for the children to follow their own questions and focus on the specific science goals of the teacher.

- In each story, there were many examples of the children using evidence from their activity to construct theories and explanations for what was happening.

- As in the life science stories, the teachers used science talks and informal discussion to encourage the children to share and clarify their thinking and as a way to assess the children’s understanding.
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