In this article, Isauro M. Escamilla Calan describes effective ways to introduce preschoolers living in an urban environment to the world of nature and gardening in developmentally appropriate and culturally responsive ways. He highlights in particular how sketching, drawing, and painting are powerful media for children's inquiry-based nature learning, and how this process helps young bilingual speakers learn ways to talk about nature with each other and with adults. Escamilla Calan explains how the use of art slows down children's involvement with nature, improves their observational skills, and deepens their symbolic and representation skills in nature exploration and learning.

—Daniel R. Meier

ISAURO M. ESCAMILLA CALAN

Drawing, Photographs, and Painting: Learning About the Natural World in an Urban Preschool

My school, Las Americas Early Education School, is located in the heart of the Mission District of San Francisco and is part of the San Francisco Unified School District. The school reflects the city's cultural and linguistic diversity and provides an environment-based curriculum using the school's garden to connect nature, outdoor learning, and academic success. Until a few years ago, the garden had been neglected and unused, a place where children ventured only by accident and where adults hardly ever set foot. Then, over the span of just a few months and with the help of a mini-grant, the children, my coteachers, and I transformed this unused space into a lively garden.

For me, "science" implies nature and greenery, something alive and thriving—the opposite of what the schoolyard environment offered the children. So I thought it would be a great idea to create with the preschoolers a space to plant, observe, and connect what we grow with some of the foods we eat. In the process, I wanted the children to become acquainted with nature and tap into what Howard Gardner (1999) calls the naturalist intelligence, which too few children in our modern society explore. I had five basic inquiry questions to start my project:

1. How can I improve the science area in my classroom?
2. How can I incorporate science and nature as a daily occurrence in my class?

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Photos courtesy of the author.

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3. How can I motivate and support the children to create a green space in our school grounds?
4. How can I use the garden as a resource to promote the learning of life science?
5. How can I incorporate my knowledge of teacher inquiry and reflection to improve my science curriculum?

The value of nature education and inquiry for urban preschoolers

The ideas and strategies in this article make visible the benefits of creating, exploring, and studying green spaces with children who live in the city. Most of the children, who range in age from 3 to 5 years old, are bilingual and speak Spanish, Mandarin, or Cantonese as their second language, which are all languages that our teaching staff speak, too. And although most of our conversations are in English, we often use the children's home language to get a better understanding of how their young minds process their nature experiences. As our nature study has progressed, we sometimes take dictation from the children in both languages, and some children are starting to write a few words in English.

When children explore nature in their own communities, they often develop a sense of respect and ownership for these places. They can learn about life cycles, natural phenomena, living systems, and how different parts come together to create a whole—for example, how a trunk, branches, and leaves form a tree. When children play outdoors in green spaces they reconnect with nature and develop a certain awareness of the role that weather, grass, water, plants, insects, or birds play in our daily lives. Whatever environment children are exposed to in their early years becomes the lens through which they perceive the world around them. If we want children to grow up and become stewards of our natural resources, they must first have easy access to environments where they can experience the delights of being in green outdoor spaces to play, discover, and learn.

Because children's science opportunities are often rather limited, "confined too frequently to the passive and secondhand experience of the television or video game" (Chalufour & Worth 2003, 2), it is essential to offer children real-life science and nature experiences. The use of visuals during those experiences to represent scientific observation and learning is a critical option for bilingual children, who are learning to speak and understand science concepts in two languages.

This is why, in our emergent life science curriculum, I emphasize the value of drawing, sketching, and painting, which allow children to produce visual representations to complement their emerging language skills in science and nature study. According to Forman and Fyfe (1998), drawing from observation as done in the Reggio Emilia preschools permits children

to generate and consolidate knowledge and to correct their misconceptions. For Malaguzzi (1998), putting ideas into visual representation helps children understand that their drawings can communicate what they sometimes cannot express solely in words. In this sense, for young children, graphic representation is a communication tool that is simpler and clearer than words, although the act of representation is complex because it requires children to make important cognitive and scientific choices based on their observations and experiences.

As Meier and Henderson (2007) explain, documenting a project-based curriculum through different media is a form of inquiry because it engages children in the inquiry process and helps teachers organize and analyze data to clarify teaching and learning questions. I wanted the children to understand the life cycle of a plant and an insect, and I also wanted to offer them opportunities to become better observers, to take their time experimenting with basic art materials, and to make symbolic representations of their nature observations.

Data collection

My teaching team used the following materials to collect our data:

- Photographs
- Audio recordings
- Teacher journals
- Children's work samples

Photographs of the children's nature learning proved to be one of our most valuable inquiry tools. My coteachers and I constantly used a camera to capture seemingly unimportant moments, only to realize later how many of these photos helped create a visual narrative of the nature project at hand. They helped us see the children's ability to work together, whether they were tending the garden, making symbolic representations in the classroom, or enjoying one of our field trips. We used selected photographs to create display panels to prompt conversations and help children focus on specific aspects of our science inquiry (Chalufour & Worth 2003). These images invited children and teachers to engage in dialogue about past events and encouraged us to make plans about other prospective activities.

Our audio recordings also proved to be valuable tools. I occasionally captured the children's dialogue with an audiotape recorder and would often play back the children's conversations for them at a later date. Reviewing these conversations helped us replay their theories in-the-making and move forward to new ideas. Though time consuming, I listened to the audio recordings several times, trying to capture the harmony and pace of the dialogue, as well as the content of the concepts the children were acquiring. Once I transcribed the children's conversations, I tried to discern why they had said what they said, and how this knowledge was influenced by the

activities we had done in class. Listening to their conversations helped me reflect on my role as a teacher and my responsibility to set up activities in which the children could increase their knowledge and challenge their theories.

My teacher research journal held my notes, descriptions, observations, and preliminary reflections and interpretations. My daily notes and observations gave me an idea of how to plan for activities that would help the children gain a better understanding of specific concepts. I also kept photocopies of drawings made by the children to accompany some of my written observations. Finally, recording some of the children's comments and questions helped me informally assess their science knowledge.

The children's representational work samples also offered a window into their thinking. I spent hours sorting out a vast number of drawings, making photocopies and sorting them all by date and categories so that I could create individual files. With an organizational system in place, I was ready to compare their early drawings with their later drawings to see if and how their understandings developed into new knowledge, especially with those children who made drawings their preferred mode of expression.

Research plan and findings

1. The process of replaying the children's taped conversations helped us determine their theories in-the-making and move forward to new ideas.
2. Representing their ideas through art slows down children's involvement with nature, improves their observational skills, and deepens their symbolic and representation skills in nature exploration and learning.
3. What started as a study of basic science knowledge evolved into a more ambitious study of exploring nature through the outdoors.
4. Slowly, this study tapped into the children's ability to care for and respect all living things, even if they do not fully understand their role in the intricacies of our ecosystem.
5. Capturing all these moments in photographs—combined with the children's comments and drawings and my reflections and interpretations—contributed to a larger view of children as active learners.
6. Documenting these experiences helped me find new meaning in the routine of my daily work as a teacher, making each day different from the one before when seen through the children's eyes.
7. Together we brought a small garden back to life, and we felt very proud of it.

The garden where we planted the first broccoli seedlings was the logical place to start our observations. Equipped with markers and paper on clipboards, the children went into the garden to draw the small broccoli plants, only to discover that someone or something had been nibbling on the leaves. They were determined to protect their baby plants and find the culprit. This is how they began to uncover intricate connections between plants and insects and became interested in the structure and life cycles of living things.

Bringing our garden back to life.

Caterpillars

When the children found several cocoons in the rose bush in the schoolyard, they were already familiar with the caterpillars that were eating the broccoli seedlings they had planted earlier.

Observation, conversation, and drawing

One afternoon, I took a small group of children to the back garden to find something that would trigger their curiosity and provoke their thinking. We found a few sticks, a pile of grass, dirt, discarded plants, and empty plastic containers that once held seedlings. It had rained two days before, so the pile of dirt and grass was damp and wet. Poking here and there, we uncovered (in Julian's words) "a family of snakes."

JG: These are not snakes.

Julian: They move like snakes. They are baby snakes.

Teacher: No, they are worms, earthworms.

Julian: Here's another, another one! So many!

JG: Why we never come here?

Omar: Look, here's another thing, but this is not a worm.

JG: Is it a snake?

Omar: No. It has many legs. But it's gone. I need a bigger stick. It's scary.

Teacher: Whatever it is, please, don't kill it.

JG: It is here. It went that way!

Omar: I think it is an insect.

We picked up a few earthworms and placed them in an ant farm to observe. During snack time, a couple of the boys began to wonder about their diet.

JG: Poor little animals, poor little things, they have nothing to eat.

Joshua: What do they eat? Apples? Insects? Paper? Flowers? People?

A few days later, we placed three of the earthworms on a piece of paper in the center of the table for a 30-minute drawing session, during which the children exchanged comments, ideas, and questions. Some of these were,

- Where is the head?
- Where is the tail?
- Why is he bleeding?
- Which one is the boy?
- Which one is the mom?
- Why is this bigger?
- They don't like the light.
- It's peach color.
- It's black inside.

I didn't answer the children's questions because I didn't know all of the answers. I could have gone to the library to research the worms' anatomy, but I wanted the children to lead the inquiry. This is a big shift in defining the role of the teacher, who most of the time is considered the holder of knowledge, the one who instructs and teaches, and the one who provides the information needed.

Another day, when the children had been looking for earthworms, they saw a blooming rosebush. Looking at the roses, they noticed some of the leaves were curled up. Intrigued, Cindy picked one leaf and opened it up. Inside the leaf she found a caterpillar wrapped in what looked like a spider web. They found a few more leaves with very tiny caterpillars inside building their cocoons. The children found no earthworms, but they seemed content with their new discovery.

We took a few leaves along with the caterpillars for closer observation to the light table in the classroom. The light table made the leaves almost see-through. We then placed the leaves in our plastic habitat box, and the children gathered to observe and discuss the newly arrived caterpillars. They used magnifying lenses to check on any new developments inside the habitat box, where the caterpillars were wrapping themselves in silky blankets. The light table and the habitat box served as the initial gathering center that encouraged the children to talk about the caterpillars, make theories, and ask questions. I captured their dialogue with written notes and an audiotape recorder, and I often played back the children's conversations later on for them. This helped us replay their theories in-the-making and to move forward to new ideas.

Observing caterpillars on the light table.

Felix: What is it?

Cindy: Caterpillars. We found them in the garden for the big children.

Felix: They don't move. They're dead.

Cindy: No, they aren't dead. They are sleeping.

Felix: Are they gonna be butterflies?

Cindy: I think so. I don't know. Teacher, are they gonna turn like butterflies?

Teacher: I think so. We'll have to wait and see.

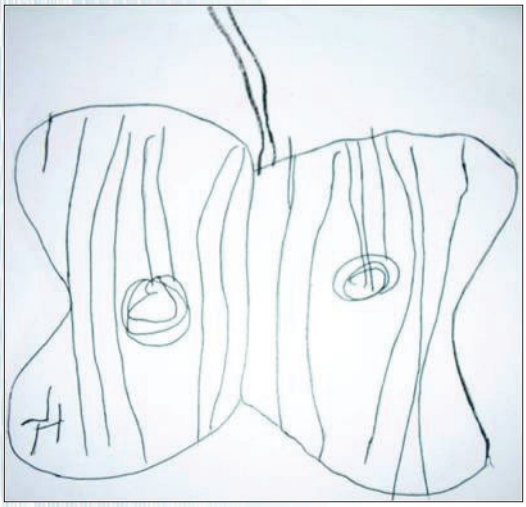
Felix asks a question that Cindy answers ("Caterpillars"), and she offers additional information explaining the location where they were found. Felix observes that the caterpillars are motionless. His observation leads him to *formulate a theory.* If they do not move, it is because they are dead. Cindy contradicts his theory and offers a second possibility. If they do not move and they are not dead, the most logical explanation, according to her experience, is that the caterpillars are sleeping. Felix seems to accept Cindy's explanation. If the caterpillars are alive but sleeping, and not dead as he had assumed in the beginning, Felix wonders if they will transform into butterflies. Cindy, who until then has shown self-assurance in her answers, offers a hesitant "I think so," and turns to me to find an answer to their question, "Will the caterpillars turn into butterflies?" I do not give them a categorical yes or no, but instead offer an invitation to observe and explore further. To maintain the children's interest, we placed the habitat box of caterpillars and cocoons on a low shelf. The children often went there to see if there were any butterflies.

We went to the public library, where we found beautifully illustrated books about nature, garden insects, and caterpillars. Some were nonfiction books with close-up images of caterpillars that allowed the children to see small details that they otherwise would not see on the tiny ones in our room. We invited the children to make representations of the caterpillars.

This drawing activity helped children pay attention to the insects' transformation. Each drawing was a unique interpretation of their observations, and no two drawings were alike. I wanted the children to feel empowered to continue their own graphic representations, and to respect and honor others' perspectives. This is an important social-emotional element in our nature work, which helps solidify us as a community of naturalists, gardeners, and scientists.

Representing the caterpillars.

A few days later, a child yelled for everyone to see the three butterflies flying inside the habitat box. There were three small brown moths, but to the children they were beautiful butterflies. Several children gathered around, surprised by the three small creatures that we hadn't seen emerge from their cocoons. A few children drew the moths while others attentively observed them during a small group activity, observing the anatomical parts of the butterflies and moths and focusing on such features as wings, thorax, legs, and antennae. The children put into practice their knowledge of animal anatomy and mathematics, which included counting, number, and symmetry. Anica drew four legs on each side of the body and counted them all one by one. Lizbeth used a magnifying lens to better observe the details on the wings, and she drew an elaborate and almost symmetrical wing pattern.



Lizbeth's symmetrical moth drawing.

The children soon learned new science vocabulary, such as *caterpillar, cocoon, antennae,* and *habitat.* I overheard Felix explaining to another child the butterfly life cycle using newly acquired vocabulary from one of the books. The children also revisited more familiar words, like *change* and *transformation,* which they related to Transformers, the flexible toys that can be transformed from a car into a superhero or a spacecraft. *Metamorphosis* was still too challenging a word for them, but that did not deter me from using it, remembering the advice of nature teacher Chris Giorni, founder of San Francisco's Tree Frog Treks Program (www.treefrogtreks.com), who uses big words such as *hypothesis* in his preschool nature presentations. He believes that familiarizing young children with science words makes it less intimidating later when they receive more academic science education. Interestingly, many of these new words had the same pronunciation in Spanish as in English, making it easier to persuade the children to use and understand the words in their home language.

Trees

Once the children's following of butterflies and bees became a routine activity in the garden, the children often looked up at the flying insects, watching until they disappeared from view among the plants or tree branches. One morning the children noticed that one tree branch had mostly red leaves while the rest of the branches had green leaves. I thought that this simple observation could lead to a new scientific discovery. The next day I took a photograph of the tree, and two days later I showed the photo to the children. Surrounded by a few children, I passed the photograph around while I asked several questions to hear their ideas and find out what they knew about trees.

Anica: Trees are for the birds to live.

Diego: Trees are big, very big.

Felix: The trees can fall when it rains.

Cindy: But they don't fall. When the wind makes them move, they hold to the floor.

Anica: The birds make a house in the trees.

Diego: Los pájaros hacen nidos. [Birds make nests.]

Felix: But when the rain is very strong and the wind is very strong too, the trees can fall.

As a follow-up activity I asked the children whether they could draw the tree in the photograph. Some children had seen the real tree, but some had not—or perhaps they had, but they had not intentionally observed it. Looking and observing are two different processes, and both are important. Looking is a helpful first step for children in selecting an object in the natural world. Observing entails focusing on that object with intention to discern particular characteristics, traits, and patterns, and children often need plenty of time and support from adults and peers for this process. To help the children become acquainted with the tree, I invited them to go with me and see the real tree in the yard. After a short observation of less than 10 minutes, we returned to the classroom and I asked the children to draw their impressions of the tree. My intention was to contrast the children's drawings from memory with ones from direct observations, which they would do a couple of days later. All the children's drawings were different, and each showed the way the individual child conceptualized and represented symbolically the same object, based on the child's age, ability to use materials, and sense of aesthetics, proportion, depth, and perception.

Diego's Tree Drawings

One morning Diego and Daniel were full of energy, jumping and tumbling on each other. I redirected them toward a more calming activity.

Teacher: How about the drawing table?

Diego: No, I don't know how to draw! (Daniel is behind him and also shakes his head at the idea of drawing.)

Teacher: Come on! It will be fun. (Diego and Daniel look at each other and agree to give it a try.)

Diego: What are we gonna draw?

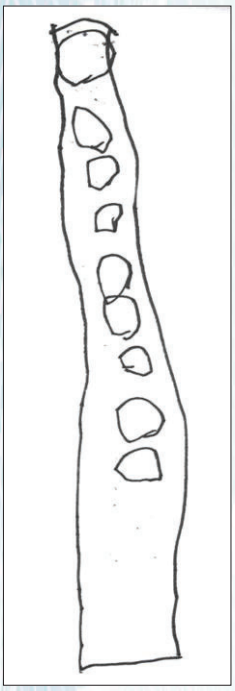
Teacher: You may draw whatever you want, but before you start I have something to show you.

Diego: What is it? (I show them the photograph of the tree.)

Teacher: Could you make a drawing of this or any other tree?

Diego: Okay, that's easy. (Diego answers with confidence.)

I put paper, markers, and the photograph on the table and told them I would return in a few minutes. From across the room I watched Diego and



Diego's first drawing of the tree.

Daniel talk to each other and look at the photo. About 10 minutes later I returned and asked them to show me what they had done. Diego's drawing was a vertical rectangle with small circles representing the leaves, from bottom to top.

Teacher: Does the tree have leaves all the way to the ground?

Diego: No. But I don't know how to make the top.

Teacher: Look at the picture and try again. I'll be back in five minutes. I think you can do it.

I wanted to offer Diego a challenging activity to sharpen his observation and representation skills. I had also noticed that he was having a difficult time tracing the letters of his name. He probably perceived letters as disconnected scribbles with no meaning and had no desire to practice writing his name. Since letters are symbolic representations of language, I wanted Diego to understand the value of communicating a message, idea, or concept through symbols. I offered him activities in which he could try to graphically represent something more concrete—in this case, the tree outside our school.

When I returned, Diego had drawn a new cylindrical shape covered from top to bottom with leaves that looked like small ovals and circles. It looked similar to the first drawing, but in his second attempt the tree leaned to the right.

Diego: I'm finished. I can't do it.

Teacher: Try again. Look, in the photo the leaves are on the top of the tree, not all over the trunk.

Diego: Okay. I'll do it again. I'll make another drawing.

Diego drawing the tree outside.

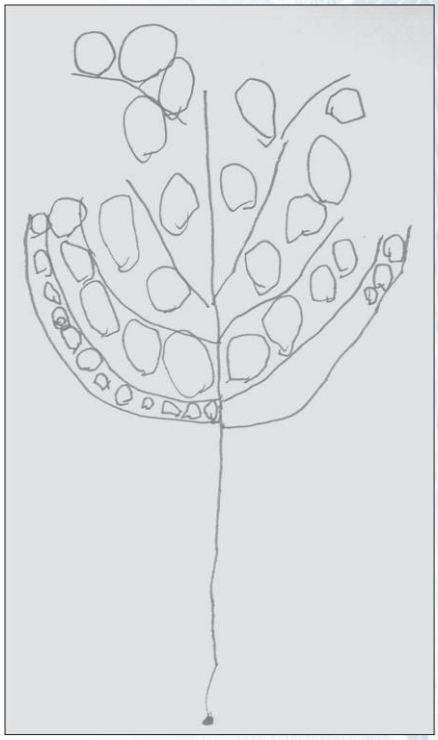
Teacher: I know what we can do. We could go outside to see the tree. Do you want to come?

Diego: Yes, that's a good idea! Let's go, Daniel. (Daniel is his best friend)

Diego, Daniel, and I went outside and looked at the tree. They brought their markers and paper, and I set up a small table a few feet away from the tree where Diego and Daniel sat down to draw. I pointed to the many tree branches, and they noticed that they curved upward and outward. Their eyes seemed to light up and their smiles made me think that they could make a more realistic drawing of the tree based on their personal observations. I again told them I would be back in a few minutes.

In his third attempt, when Diego was outside looking directly at the tree, he drew the tree with a trunk and a canopy. However, he realized that the leaves were not attached to the branches. In fact, he had drawn only two

branches and many leaves suspended in the air. In his fourth and last attempt Diego added several more branches and positioned them to the right and left of the trunk in an upward position toward the sun. He covered all the branches with leaves. The way Diego positioned the branches gave the illusion of multiple layers decreasing in size as they go up the tree. The branches extended symmetrically to both sides from the trunk. At the very top of the tree canopy, Diego added a few smaller branches, placing one on the right side and one on the left.



Diego's fourth drawing of the tree.

Diego's intricate sequence of tree drawings revealed that young children are capable of observing, focusing, and making detailed graphic representations to deepen their understanding of specific aspects of nature. They are also capable of sustained concentration and of drawing new drafts as their observations become more accurate and sophisticated. In this drawing session with a friend, Diego noticed details of the tree's structure. He learned that the trunk is always attached to the ground and the truck extends upward, creating a multitude of branches. He noticed that leaves comprise the heavy foliage on top and that these leaves are attached to branches. In his fourth and last drawing Diego represented the lower branches as thicker and stronger than the branches at the very top. As he added new branches to the tree, Diego made them shorter and thinner. It seems that Diego discovered that the higher the branches are, the smaller they become. He also seemed to know that the tree has main branches and secondary branches. By focusing in on specific parts of the tree, Diego understood how they interconnect and need each other to make a whole, pretty much the same way that specific marks form separate letters that, when put together, can form and represent his name.

Diego's and the other children's drawings helped them focus on small details and enriched and facilitated later discussion on trees. When young children focus their observations and ask specific questions about plants and animals, they are often ready for more extended explorations (Chard 1998). Chalufour and Worth (2003) consider representational drawing a way to help children discover nature's patterns and characteristics; as Diego demonstrated, I would add that drawing offers a developmental bridge from sketching to writing.

Final thoughts

This study of caterpillars, butterflies, and trees started with the mystery of someone or something eating our broccoli plants and ended four months later with the knowledge of the biological interrelationships between butterflies and plants and gardens. An effective life science curriculum for young children does not necessarily emerge from a set of materials purchased from a catalogue, or from preplanned lessons written by experts. Instead, as I strongly believe, children's natural curiosity and their

inquisitive minds can be used as catalysts to learn about the natural world in deep and sustained ways.

Yet, even in an emergent curriculum or a school, these experiences do not just happen. It takes the commitment, organization, collaboration, and understanding of adults in our roles as guides and facilitators to ensure that children's play and ideas about science and nature are focused, studied in depth, and sometimes even challenged. Through our nature studies I discovered that most children have the disposition to learn about science content when provided with unhurried time to observe and reenact and extend their understandings through writing, drawing, painting, constructing, and role-playing. As teachers, we learned to make art materials easily accessible both indoors and outdoors.

These children learned about the life cycle of plants firsthand and patiently watered the seedlings until they became fruit-bearing plants, ready for harvesting. They witnessed the transformation of caterpillars and changed their opinion of bees. At the same time, they started to envision the possibility of different creatures co-existing in the same school garden, each playing an important role in our small, local ecosystem.

I discovered that working with small groups of children gave me the time and space to observe and document the children's explorations and understanding of math, nature, and science concepts. I introduced these open-ended activities as another choice for the children, and more often than not, the activities emerged from the children's innate curiosity and interests. Working with a small group provided ample opportunity for closer social interactions among the children and allowed me to see the evolution of our scientific knowledge as a community. I got to know the children better individually and developed a better understanding of my role in supporting their construction of scientific language and knowledge. For example, one day, while out in the garden with five of the children, I asked them a few questions about gardening, such as "Why is a garden a good idea?" and "What animals and insects do you hope to find in the garden?"

Felix: So that the plants can breathe outside. So that when the bees go looking for the flowers and plants they go outside not inside, and they don't sting us.

Diego: Para que crezcan las plantas. [For plants to grow.]

Felix: It's good to have flowers so we can smell them.

Sharina: It's good to have flowers for the butterflies to eat.

Cindy: Butterflies eat miel de las flores [nectar from the flowers]. Bees, they eat honey, too. Butterflies like to eat the outside part of the flowers.

Felix: Butterflies like to eat the outside part of the plant, the flower (pointing to a petal). One day I saw a butterfly putting her head inside the flower and the bee, too. It went all the way inside.

The children's responses revealed what they had learned throughout our study.

I also more clearly saw how successful nature study for teachers and children is founded on encouraging children to ask questions, observe closely over time, and think about what their observations tell them. An environment that promotes inquiry about science or any other topic uses children's ongoing dialogue, artwork, charts, photographs, artifacts, and panels to communicate to teachers and families the richness of the learning process. This kind of environment also promotes inquiry through social interaction, exchange of ideas, collaboration, reflection with peers, and building on one another's work and theories. After all, nature study is more than knowledge. It is a process of exploration, communication, creation, and discovery with others. This is especially important for young children living in urban environments, and for children who are bilingual and juggling the learning of science vocabulary and concepts in more than one language. For these children, a nature curriculum that integrates drawing and painting and other visual forms of representation is a powerful tool for scientific understanding.

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