


The Office of Head Start Teacher's Guide to the Discovering Science Webcast Series

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INTRODUCTORY TEACHER'S LETTER

Dear Teacher,

A Teacher's Guide to the Office of Head Start ***Discovering Science Webcast Series*** is designed to take you, the children you work with, their families and your colleagues on a journey through scientific thinking and exploration. This journey will reveal countless possibilities to make science a fun, exciting, and extraordinary learning experience.

Children are born highly motivated to explore, question, investigate, and discover their world. This guide offers a blueprint for building on their natural tendencies to question how the world works and why. It serves as a companion to the *Discovering Science Webcast Series* created by the Office of Head Start (OHS). The series includes four Webcasts:

1. ***Let's Do Science.***
2. ***Look What I Know. See What I Can Do!***
3. ***Science Through Language and Literacy***
4. ***Bringing It All Together in Effective Environments***

Throughout this journey, we hope that you will trust your curiosity and rediscover your inner child. By asking yourself the following questions, we hope that you can lead the children you teach on the way to exciting discoveries:

- If I were a child in my classroom, what would I wonder about?
- What would I want to explore inside and outside?
- What ideas would I have about how things work?
- What do I think would happen if I did this?

Thank you for the contributions you make each and every day to the lives of Head Start children.

Now, let's **discover science!**

Sincerely,

Yvette Sanchez Fuentes
Director
Office of Head Start

A TEACHER'S GUIDE TO THE OFFICE OF HEAD START DISCOVERING SCIENCE WEBCAST SERIES

About This Guide

The Office of Head Start (OHS) developed this teacher's guide as a companion to the Discovering Science Webcast Series. Its purpose is to extend the impact of these webcasts by:

- increasing teachers' use of research-based practices in early childhood science;
- supporting teachers' intentional planning for and implementation of science discoveries;
- strengthening language, vocabulary, and literacy skills through science explorations;
- helping teachers engage children in the key science process skills of observing, predicting, investigating, classifying, and communicating, which are the basis of critical thinking and learning; and
- encouraging teachers to engage families in science experiences with children as they support parents in their roles as their children's first teachers.

This guide is a basic introduction to science for young children and includes a variety of resources to help explore science in a fun and effective way.

Investigating questions that arise from children's experiences and interests is one of the best ways to promote science in early learning environments. This guide provides material to teach science well, based on almost any question children might ask. Learning to take full advantage of every opportunity to use the science process skills will ensure that children's science learning experiences will be **valuable** and long-lasting.

Information in this guide is organized around these key science process skills. Within each process skill, we describe what science looks like to young children and suggest research-based strategies to promote science learning. We explore effective questioning and the role that both the environment and teacher play in children's learning. We also address typical challenges teachers may face as they bring enriched science to the classroom.

While you may use this guide on your own, we encourage you to form a learning community with other teachers and child care providers. Learning communities offer teachers opportunities to get together with their peers to talk about current issues. They often encourage dialogue, discussion, reflective thinking, and collaboration.

Participating in learning communities can deepen and enrich your knowledge of the content in the guide and the webcasts, as well as deepen your understanding of suggested strategies to promote young children's science learning.

Linking to the Discovering Science Webcast Series and Resources

An exciting feature of this guide is that you can link directly to related science content on the Early Childhood Learning and Knowledge Center (ECLKC) website. When you encounter an orange word or phrase or blue word or phrase in the guide, it means additional resources are available. Simply activate the **orange link** to automatically view selected video clips; activate the **blue link** to access related resources that enhance the information in the guide.

Much of the linked content is from the OHS Discovering Science Webcast Series. These webcasts provide information on early childhood science and include interviews with teachers, administrators, and early childhood science experts. The webcasts also include videos of science explorations. You may view each webcast in its entirety on the **ECLKC**.

Enhancing Your Curriculum

Also included on the ECLKC website are teacher resources for *Marvelous Explorations Through Science and Stories*, or *MESS*. *MESS* guides offer a series of early childhood science experiences developed with OHS Innovation and Improvement funds. Further, *MESS* provides basic information for teachers to understand specific science concepts.

MESS is a flexible resource designed to guide teachers as they incorporate more science into their classrooms. It offers examples of research-based practices that support children's development of science understanding and process skills. *MESS* suggests resources, materials, books, experiences, and family connections that teachers can use to respond to children's curiosity about many different topics, including animals, plants, **insects and spiders**.

PART ONE: SETTING THE STAGE

What Does Science Look Like in Early Childhood?

Young children are natural scientists. They spend much of their time trying to figure out how their world works. Children continually observe what occurs around them. Over time, watching creates a sense of expectation. Even **infants** can predict how a person or object will behave in certain circumstances—and show surprise if their prediction is incorrect!

Young children's investigations are hands-on. For example, a child who bangs a rattle on the table will discover that it makes a great big noise. But banging it on a friend will cause that friend to make a great big noise!

Based on these investigations, young children begin to organize their world into categories, or classifications. At about a year old, infants begin to understand the difference between living and nonliving things and can categorize birds, things that don't fly, food, and vehicles. Around this time, they also begin to share their discoveries. Imagine the young toddler who looks gleefully at his caregiver as he dumps a basket of toys, as if to say, "Look! I've discovered that every single time I do this, all the toys fall out!"

Young children can use the scientific process skills discussed in this guide quite naturally. When supported by teachers who treat them as real scientists, children's learning opportunities can expand beyond **imagination**.

In this guide, you will find out more about how young children are already discovering, and perhaps initiating, investigations. You will learn how to support them in their learning. To become an effective participant in this teaching-learning process, some basic information and context are necessary.

Several overarching, research-based areas of practice are important to young children's science exploration and discovery. Extensive research informs the early care and education community about:

- teaching with intentionality;
- using questions;
- individualizing for all children; and
- using the environment as a learning context.

Part One of this guide addresses each of these four overarching areas of research and specifies how teaching teams can use the research to help children develop science process skills. Part Two of the guide examines each of these basic process skills. Each examination offers concrete examples of how the overarching areas of research relate to creating effective science learning environments for infants, toddlers, and preschoolers.

Intentional Teaching

The learning and developmental outcomes included in the **Head Start Child Development and Early Learning Framework** and in many state early learning standards are goals that are foundational to school readiness. They are used to frame how teaching teams structure the learning environment, learning experiences, and their interactions with children.

When teaching reflects thoughtful, purposeful planning and implementation, instruction is delivered with intentionality. To support the desired learning outcomes, a teaching team needs to **plan learning experiences** and use research-based teaching strategies in thoughtful and intentional ways. Learning is purposeful when it is focused on child outcomes.

To be intentional, teachers need to understand how:

- young children learn and develop;
- to observe the interests of young children closely;
- to use effective teaching strategies to promote this learning and development;
- to measure children's progress toward overall goals; and
- to actively engage with children, paying attention to:
  - differential abilities;
  - social and regulatory skills; and
  - cultural diversity and dual language learning.

Research asserts that intentional teachers maintain a "working knowledge of relevant research, are purposeful and think about why they do what they do, … and combine knowledge of research with professional common sense."

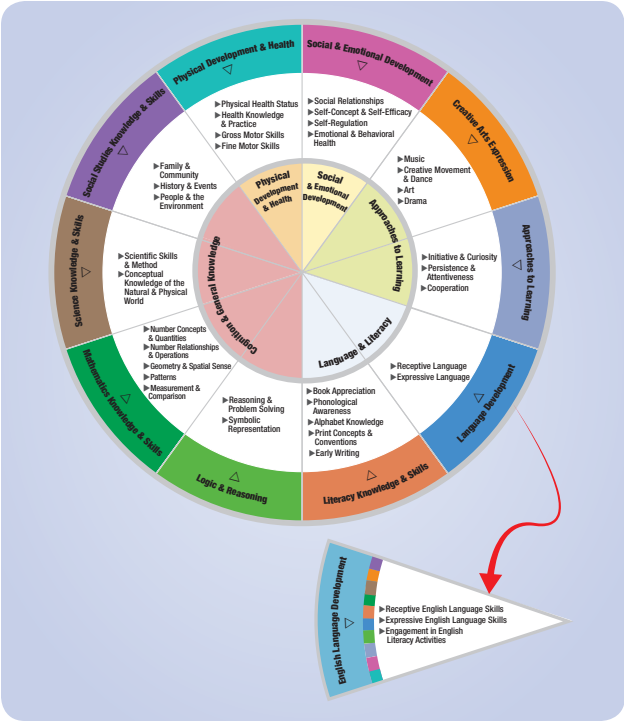
Intentional teachers reflect on their teaching. These reflections focus attention on understanding how and why children respond to the learning experiences and how children's progress toward learning outcomes can be considered in planning for next steps to promote each child's progress (Duncan 2009; Epstein 2007; Slavin 2000).

Here are five questions intentional teachers consider as they plan, teach, reflect on, and revise their practices:

1. What am I trying to accomplish? What are my learning and developmental goals for each child?
2. What are children's relevant experiences and needs?
3. What approaches and materials help me challenge every learner?
4. How will I know whether and when to change strategies or modify learning experiences?
5. What evidence do I have that children are making progress?

Child Development and Early Learning Framework

The Head Start Child Development and Early Learning Framework (2010) supports teachers' responses to these questions and undergirds **intentional practice**. The Framework provides a set of consistent, research-based, developmentally appropriate outcomes for preschoolers in Head Start. These outcomes are identified as long-term goals in several general domains, including science and approaches to learning. These domains include **many domain elements** and examples of children's skills, abilities, knowledge, and behaviors.



This graphic shows the domains that are considered the developmental building blocks most important for a child's school and long-term success. The domain of Science includes both (1) Conceptual Knowledge of the Natural and Physical World and the (2) Scientific Skills and Method are included within the processes of exploration and discovery. Throughout this guide the Scientific Skills and Method are identified as science process skills, and are found in a number of the domains and domain elements. Beginning with Approaches to Learning, we examine how children's dispositions are the basic foundation of learning science.

Approaches to Learning

Scholars and researchers describe children's characteristic responses to learning experiences in a number of different ways. Dispositions of learning, which include curiosity, creativity, persistence, and resourcefulness, support children's achievement and are vital to the learning process. Lilian Katz, professor emerita of early childhood education at the University of Illinois at Urbana, Champaign, and an early childhood education expert, defines disposition as "a tendency to exhibit frequently, consciously, and voluntarily a pattern of behavior that is directed to a broad goal."

What this means is that children can learn skills and acquire knowledge, but it is important that they also develop the disposition to use them. Dispositions allow children to engage in **intellectual pursuits and deep study** of everything around them.

EXTENDING YOUR LEARNING

Read the article entitled ***Why Children's Dispositions Should Matter to All Teachers***. After you read the article, consider or discuss the questions below with your colleagues. As you read, remember that dispositions of learning are included in the Head Start Child Development and Early Learning Framework under the Approaches to Learning domain.

- Why are dispositions and/or approaches to learning important?
- Share an experience from your classroom and the dispositions of learning you observed. What extended learning activities can you think of that could strengthen the dispositions you observed?
- Creativity, independence, self-motivation, and resilience are four dispositions of effective learners discussed in the article. What do you do in the classroom and what in your classroom environment supports each of these dispositions?
- How do you demonstrate persistence, resourcefulness, and creativity while working with children?
- How might you encourage dispositions—for example, persistence—that you don't see in a child but that you know are important to future school success?

The Head Start Child Development Early Learning Framework reflects some dispositions of learning in the "Approaches to Learning Domain," which includes initiative and curiosity, persistence and attentiveness, and cooperation (see examples below). Essentially, dispositions of learning and approaches to learning refer to children's responses to learning experiences. Although the Head Start Child Development and Early Learning Framework is an outline of the goals toward which preschool children should be progressing, some of the specific behaviors described in the examples begin in infancy and continue in toddler development, as well.

Young children's approaches to learning are powerful predictors of their later school success. These approaches influence children's development and learning across all other domains, such as literacy, language development, logic and reasoning, math, and social and emotional development, and are relevant to the science process skills identified in the Early Learning Framework.

Approaches to Learning refer to observable behaviors that indicate ways children become engaged in social interactions and learning experiences. These include:

- **Initiative and Curiosity**—an interest in varied topics and activities, desire to learn, creativeness, and independence in learning
  - Demonstrates flexibility, imagination, and inventiveness in approaching tasks and activities;
  - Demonstrates eagerness to learn about and discuss a range of topics, ideas, and tasks.
  - Asks questions and seeks new information.
- **Engagement and Persistence**—the ability to begin and finish activities with persistence and attention
  - Maintains interest in a project or activity until it is completed.
  - Sets goals and develops and follows through on plans.
  - Resists distractions, maintains attention, and continues the task at hand through frustration or challenges.
- **Cooperation**—an interest and engagement in group experiences
  - Plans, initiates and completes learning activities with peers.
  - Joins in cooperative play with others and invites others to play.
  - Models or teaches peers.
  - Helps, shares, and cooperates in a group.

Strengthening Approaches to Learning

The following suggestions can help strengthen children's approaches to learning:

- provide opportunities for spontaneous play that encourage children to be curious and imaginative and give them time and chances to manipulate, construct, and transform materials;
- provide group projects that stimulate curiosity, investigation, observation, and persistence;
- model positive approaches to learning—make them visible to children;
- acknowledge approaches to learning when you observe them in children;
- set learning goals that focus on what children are doing, rather than simply evaluate performance;
- say to children, "See how much you can find out about …," rather than "Show me how well you can do…."; and
- provide a learning environment that is caring, welcoming, stimulating, and **encouraging**.

Curiosity: One of the Domain Elements of Approaches to Learning

Curiosity underlies all scientific discoveries. Wanting to know more about something, wondering what would happen if …, seeing an object or concept through a different lens or set of experiences, wanting to make sense of the world—this is curiosity.

Infants and toddlers are curious about their world and, if encouraged, will explore, become deeply engaged with, and investigate their desire to know what's going on around them and how they can impact their environment. Adults who work with infants and toddlers have a key role in supporting and extending children's curiosity. When caregivers view very young children as emerging scientists, they can begin to see the **natural scientific thought** processes occurring.

When an infant stares out the window at blowing trees, she may be wondering to herself why these trees, usually so still, are moving around today. An observing caregiver might comment and begin a conversation about the wind, which may even lead to a walk outside to feel and hear it. By watching and following children's leads, a caregiver or teacher can support even the earliest scientific inquiries.

Curiosity can spark creativity. Curiosity prompts children to explore and ask all kinds of questions.

And it motivates them to discover their environment and everything in it.

Young children bring their curiosity wherever they go. When teachers and caregivers respect and nurture this curiosity, children are encouraged to appreciate the joy of learning.

Teachers need to be motivated by curiosity as much as the children they teach. For example, do you ever sit quietly and intensely observe children, wondering what they are thinking? Are you curious about why they do or say certain things? Do you want to understand how children learn and how you might expand their learning opportunities? Your own curiosity helps you enrich your children's learning.

EXTENDING YOUR LEARNING ABOUT CURIOSITY

It is important for teachers to model curiosity and the process of discovery for children, rather than simply answer their questions. Think of a time a child showed curiosity about something. Then try to answer these questions:

- How did you respond to that child?
- Were you able to talk with the child about his or her curiosity?
- How did you extend the child's learning?

As we seek to learn more about the children we teach, we observe, listen, question, and wonder. In other words, we are curious about them. And when we show interest in their words, questions, and behaviors, they feel important and respected.

Think about the questions below. You might want to discuss them with your learning community.

- What is the impact of valuing children's curiosity on their self-concept and confidence?
- How can you model curiosity for children?

Questions and their Role in Science Discovery

Exploring and discovering science offer children a unique opportunity to develop oral language skills. A teacher's role is to carefully and thoughtfully construct questions and use language to communicate ideas, observations, and predictions to children about what interests them. How can questions and conversations deepen children's curiosity about science activities?

Open-Ended Questions

Open-ended questions encourage more than simple "yes" or "no" answers. Questions such as "Why does that …" or "What do you think will …" require children to think in more complex ways as they explain. Even infants, who obviously cannot answer, will benefit from caregivers who make it a habit to ask them what they think, how something feels, or what might happen "if."

The importance of open-ended questions is that they advance children's language skills while giving teachers insight into how children are interacting with scientific materials and investigations. This insight allows teachers to expand children's experiences using science process skills, as well as their vocabulary and language skills. Below are some starting points for open-ended questions. Sample questions like these appear throughout the guide to help you stimulate children's thinking during the different phases of the science learning process:

- I wonder why …?
- How does this …?
- What makes you think so?
- What will happen if …?
- How is _____ like _____?

The important thing to remember with open-ended questions is that they initiate conversations about ideas. Once children begin their dialogue, follow their lead. Don't overwhelm children with too many questions. After asking a question, pause, wait for a response, and then extend the children's ideas. This will encourage back-and-forth exchanges and deepen children's understanding about their theories. Once you begin to follow where a child leads, you might:

- comment and wait for a child's reaction or response;
- ask questions and wait for a reaction or response; or
- respond by adding a little more information and waiting for a reply.

When adults follow a child's lead, the child is more likely to interact and continue the conversation. Waiting silently five or more seconds for a child to answer gives the child time to think about what was said, find and organize the words he knows to answer the question, and frame his response. When adults rush a response, a child is more likely to give a short answer with simpler words and phrases. Waiting encourages the child to say as much as he can and to try new and different vocabulary. Infants and toddlers with emerging oral language skills might find different ways to communicate, perhaps using gestures, grunts, single words, or a shared gaze.

Language Modeling

Questions are an excellent place to start when participating in science with children. But they are

only one part of a process called language modeling. In addition to open-ended questions, language modeling (carried out by teachers in the classroom and parents and caregivers in other environments) includes conversations, repeating and extending children's ideas, self talk and parallel talk, and using more advanced vocabulary and complex sentence structure.

Self talk is when adults narrate what they are thinking or doing. They talk about different ways to solve a problem, such as: "How can I get this block to balance? I'll try to put it carefully on top of my tower. Wow, it stayed there!"

Parallel talk is a strategy adults use to describe what children are doing. As a child is stacking blocks, the adult can repeat what is happening with words—for example, "You placed a blue block on top of the yellow one!"

Classroom conversations offer children a chance to express their ideas, find reasons for what they believe, and use more complex vocabulary. While exploring with children, teachers encourage conversations by repeating to children what they said, extending ideas, and using self talk or parallel talk.

A good goal is to aim for at least five back-and-forth exchanges in a conversation with children—and to build in "wait time." Two examples are to the right.

Head Start classrooms and other learning environments should be rich in language modeling, as in the examples in the next column. Ms. Lucia took the time to wonder with Carlos about why ants were marching and to discover Carlos' theory of where the ants were going. Both Ms. Lucia and Ms. Candace took the time to engage with the children in their care, and in doing so, supported language development. Scientific investigations and discovery should be this rich in language modeling.

Asking questions and engaging in language modeling activities with children help increase their oral language skills and vocabulary. Hart and Risley (1995) highlight the amazing benefits of a rich vocabulary and its effects on later reading skills, as well as the differences in vocabulary between low-income children and their middle-income peers.

On average, children between 18 months and six years old learn about nine words a day. By age six, children may know as many as 14,000 words. **Hart and Risley** (1995) also report that children from low-income households are exposed to far fewer words than those who do not live in poverty. In fact, by age three, children raised in poverty know an average of 500 words, compared to well over 1,000 words for children from professional households.

What the research tells us is young children need to have varied opportunities to build their oral language skills and vocabularies. When you engage children in the science process skills, opportunities to build vocabulary abound!

EXAMPLE 1:

Ms. Lucia: Carlos, I wonder why the ants are all marching in a row.

Carlos: Because they are going away.

Ms. Lucia: Where do you think they are going?

Carlos: I don't know. Maybe home.

Ms. Lucia: Hmmm. You think the ants are marching home? So they are leaving the sidewalk to go home.

Carlos: No, actually they are leaving the sidewalk to go in a little hole. I don't know if they all live in the same home.

Ms. Lucia: Oh, they are all going down into a little hole in the sidewalk. They might not live together in the hole. What do you think might be down that little hole?

Carlos: I don't know if there is a home down there. Cause if they all live down in that hole, I think they might be crowded if they all lived in the same house. That's a lot of ants.

Ms. Lucia: It really would be crowded.

Carlos: Yes, a really crowded ant house.

EXAMPLE 2:

While sitting on a blanket on the grass, Ms. Candace and her children, including eleven-month-old Josiah, are looking around the play area. Suddenly Josiah looks alert, and scoots closer to Ms. Candace. He points to the tree and says, "da!" Ms. Candace looks where Josiah is pointing and sees the object of his interest: "Oh, I see what you see Josiah. That is a squirrel. What do you think he's doing in that tree?" As Ms. Candace waits and watches Josiah, she sees him thinking, wondering, and trying to figure out what a squirrel is and how it fits with what he knows about the world. He again says, "da!" Ms. Candace wonders if he is trying to say "dog," and makes a note of her observations and considers that perhaps Josiah is beginning to see some similarities between a squirrel and a dog.

Rich Vocabulary

Intentional, complex **vocabulary** can enhance children's science process skills.

Complex words are often referred to as "juicy" or "delicious" words. This vocabulary is exciting, intriguing, and fun for children to learn and use. Children easily learn new words while investigating. For example, if a science investigation is about water, the following vocabulary words become important in discussing and exploring the different states of water:

Juicy Words Associated with Water		
cohesion	evaporation	solid
density	gas	solution
displace	liquid	suspension
dissolve	molecule	volume

Teachers can use these words as children make new discoveries during their playful investigations. Be careful not to introduce rich vocabulary as a drill, practice, or performance activity. Vocabulary words should relate to what children are learning and link to concepts they already understand, through a strategy known as scaffolding.

Using Books to Extend Learning

As you begin to incorporate more science into your curriculum, think about **using books** to extend children's scientific discoveries. Both fiction storybooks and nonfiction resource books can complement children's investigations. MESS includes many examples of both fiction and nonfiction books that can foster vocabulary development.

Books also can be a great way to practice observation and prediction skills. Try a story walk (looking at the book without reading it) as children work on noting details of the illustrations. Books like *The Very Hungry Caterpillar* by Eric Carle and *Brown Bear, Brown Bear* by Eric Carle and Bill Martin, Jr., provide many opportunities for children to practice their prediction skills based on the story narrative. Pausing between pages, stopping and studying the illustrations, and asking children to point out details help spark children's interest and hone their prediction skills.

Reading Strategies

Reading books to enhance the science process skills and scientific explorations allows teachers to engage in dialogic reading strategies. These strategies engage children in conversation before, during, and after reading a story. Numerous studies and the National Early Literacy Panel confirm that dialogic reading strategies are among the most powerful techniques adults can use to promote children's language and

literacy development. These strategies have been shown to increase children's abilities across a wide range of languages, including English, Spanish, Portuguese, Hmong, Korean, and Cantonese, as well as with children with disabilities.

Individualizing for Every Child

Individualizing instruction for every child and intentional teaching are foundational to effective practice that supports science discovery. Part Two, Science Process Skills—A Framework for Discovering Science, addresses appropriate experiences that promote the development and learning of infants and toddlers, **children learning more than one language**, and children with special needs.

Looking at Infants and Toddlers

Infants, toddlers, and two-year-olds are in a constant state of discovery. Each new sound, sight, smell, touch, and taste lets them learn about a big, new world. Teachers, parents, and caregivers can capitalize on these experiences and plan for new ones. When planned within a responsive routine, a variety of experiences can enrich your center-based, home-based, or family child care program.

Supporting Children Who Are Dual Language Learners

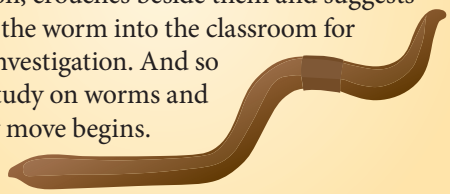
When planning for specific children in your class, it is important to understand the strengths and needs of each child. Children who are dual language learners—learning both English and a home language other than English—need **specific strategies** to maximize their learning.

Science is great for sparking children's interests and engaging all learners in the discovery process. For children learning English, be aware of nonverbal behavior and accept minimal verbal responses. Engage other children in the discussion. Help other children connect with nonverbal communication that dual language learners might use, such as pointing, gesturing, and making different facial expressions. It's a good idea to initially limit these experiences to a small group so the children will feel supported and willing to take risks to communicate in a new language.

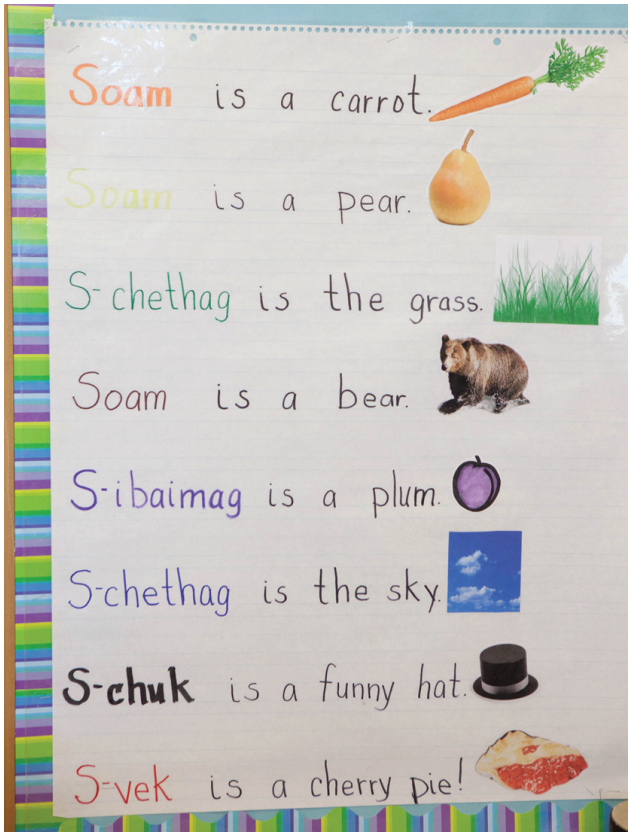
Children who are dual language learners will gain valuable linguistic and cognitive skills through scientific investigation. Curiosity propels engagement, and engagement facilitates learning. Use science activities to **increase basic vocabulary**, particularly concept words in both home languages and English. To strengthen cognitive skills, plan to spend time with individual children and model the processes of sorting, classifying, and investigating.

In the example below of an investigation that stems from children's interests, a teacher has an opportunity to engage children, introduce various investigative processes, and facilitate family involvement. During a study, encourage children to use multiple data collection methods and record what they see in journals.

Tomás and Eva, on their way into the classroom, discover a small worm. Tomás picks it up and it begins to wiggle. Immediately, he drops it on the ground! Eva smiles as she picks it up, and places it in her hand. Together they giggle. Ms. Rodriquez, after observing the interaction, crouches beside them and suggests bringing the worm into the classroom for further investigation. And so a small study on worms and how they move begins.



When you introduce new pieces of equipment into the class, make sure to label them in both English and the children's home languages. Involve parents in science discoveries in as many ways as possible, from requesting that they bring in a natural item from around their homes to asking them to host a science exploration day. Remember that science is natural for all learners and can be individualized for the children in your classroom.



Planning for Children with Disabilities

Teachers and assistant teachers respond positively to differences in children's abilities, interests, and experiences. They focus on planned developmental activities for individuals and small groups of children.

Children build on their experiences in an environment that is predictable and routine, but also stimulating and challenging. Accommodating children with special needs may include a variety of instructional strategies, such as:

- breaking down concepts into smaller parts;
- modifying and sequencing tasks;
- using activities for graduated prompting;
- using multi-sensory ways to communicate;
- modeling and demonstrating;
- explicitly teaching rehearsal strategies that help focus attention; and
- partnering with peers.

Throughout Part Two of this guide, there are many specific illustrations of how these strategies for working with children with disabilities can foster inclusion.

Family Engagement and Linking Science to Home

Strong parent partnerships are essential to the success of Head Start and Early Head Start programs. Research shows that when parents and families play an active role in children's learning, children are more successful in school. To encourage family connections, teaching teams communicate fun and interesting ways adults can encourage science learning and children's curiosity. Appendix A offers sample letters to parents and families to introduce the process of experiencing science in Head Start.

Beginning with a focus on using open-ended questions and the idea of a five-second "wait" time when asking questions, there are countless other ways to foster a family's engagement in their children's learning. Model and demonstrate for families how they can reinforce their children's learning. Ideas could be as simple as reading books together and talking about new things in the home, favorite foods, the weather, similarities and difference among people, and seasonal changes.

Planting seeds, taking walks, and visiting parks, **nature** areas, museums, and playgrounds all offer a chance to engage young children.

Families also can encourage children's sense of discovery and exploration by:

- asking children thought-provoking questions, such as, "What do you want to find out?" and "How do you think it does that?";
- following their children's lead and allowing them to show their interests; and
- replacing "I don't know" responses with "Let's find out."

The Role of the Environment in Discovering Science: The Environment as the Third Teacher

As a teacher, the classroom environment you provide is key to successful science learning for young children. In fact, the environment is often referred to as the "third teacher," following parents and classroom instructors.

Every learning environment, including the classroom, sends children important messages and cues about what you value and consider important. The materials and tools you choose and how you display them, how you introduce materials and the way the classroom's centers are arranged all affect how children interact and learn.

Classroom materials should provoke questions for children to answer. Too many materials, or simply adding items over time, can cause children to get confused or over stimulated. It is better to periodically rotate materials, removing older items when adding new ones. A controlled but interesting environment with activities that offer meaningful interaction help children focus and explore materials in depth.

The classroom environment should be structured to invite conversation and collaboration among children. For example, a science center should be large enough for more than one child and contain a work area where small groups of children can interact. While it should be obvious to the children that this center is the science area, the space needs to be well integrated with the rest of the classroom, as science discoveries may occur anywhere throughout the class.

The environment should showcase and document children's thinking. Children's drawings, diagrams, graphs, and writing give teachers and parents insight into the depth of children's understanding. Developing learning stories or explanations, accompanied by photos and writing that reflect children's scientific experiences, allows parents and teachers to join in the children's learning. Documentation makes the classroom more meaningful for children, shows teachers value their ideas, and encourages further exploration.

The **outdoor environment** provides a wonderful laboratory for learning science. Interacting with nature is important for young children, offering them many diverse learning experiences. Research shows children demonstrate more creativity and cognitive flexibility when they are able to problem solve in natural settings. Regardless of where your program is located, nature can be an integral part of children's learning.

Throughout this guide, there are references to the environment and how to prepare settings that foster scientific inquiry. These ideas and suggestions, along with carefully listening to and observing the children, will help you provide rich surroundings in which they can learn science. In Appendix B you'll find a list of Frequently Asked Questions with some practical responses that may support your understanding of how to encourage early childhood science and discovery.

Developing an Effective Teaching and Learning Environment

To help you assess your teaching and learning environment, watch and consider **how children use** the area and whether or not it effectively meets their needs and learning goals. As you observe, ask yourself the following questions:

- When I enter the classroom, does the room invite me in? Do I want to stay and explore? Are there areas that attract my attention?
- Does the classroom environment offer choices of things to do?
- Does the environment provide science messages to children?
- Does the environment encourage conversation and collaboration among the children?
- Are the materials:
  - displayed in a way that is interesting to children?
  - designed for multisensory learning?
  - suited for letting children explore, experiment, and learn?
  - designed to stimulate imagination and creativity?
  - open-ended, letting children interact with them in a variety of ways?
  - designed to offer children a chance to develop their own ideas and theories?
- Do the materials and environment support inquiry?

Don't Forget the Tools

Providing quality **equipment and materials** that support children's effective and independent investigations reflects respect for children's learning and curiosity. Creating an environment for science discovery does not have to be an expensive task.

There are many everyday objects—some right in your classroom, such as wooden blocks or animals, and some easily found at thrift shops or tag sales—that could support scientific explorations. A list of useful equipment to consider is to the right.

Avoid costly equipment that has limited use. For example, a microscope that works only with prepackaged slides may be high quality, but has little use beyond the set of slides offered by the manufacturer. Children should begin to understand that such a tool can support investigations and explorations of many different phenomena. Also, natural sponges that expand into large dinosaur shapes have limited value.

Another way to build science resources and support the environment at the same time is to collect recyclable materials such as cardboard or plastic containers, plant seedlings, and objects made from a variety of substances. The materials don't have to be fancy to be useful—just make sure they are safe for young hands.

The next section of this guide will look at how young children use their science process skills, both inside and outside the classroom, to explore their world.

Useful Equipment

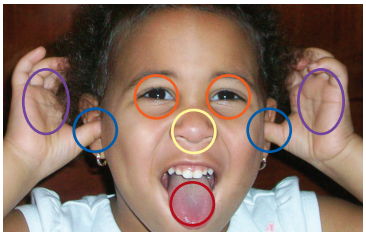
- ☐ eyedroppers
- ☐ hand-held and table-top magnifiers at least 10 times greater than the human eye
- ☐ small clear containers for collecting and displaying objects
- ☐ an aquarium
- ☐ blocks with ramps
- ☐ water bins or tables that can be sanitized easily
- ☐ a digital camera
- ☐ a color printer
- ☐ clipboards, paper, pencils, and markers

PART TWO: SCIENCE PROCESS SKILLS

A Framework for Discovering Science

This section of the teacher's guide is organized around science process skills. Science process skills are basic actions we use to explore and make meaning of the world. They define how children approach **exploration** and discovery as they learn.

Science process skills are central to approaching any problem-solving opportunity and can be applied to any topic. These skills represent the common denominator of how children learn science. Understanding what these process skills involve and how to foster them will help you approach any science exploration with confidence. The skills highlighted in this part of the guide are:

OBSERVING		Using the **senses** to learn
PREDICTING		Forming an opinion about what might happen
INVESTIGATING		Systematically studying objects and events or activities
CLASSIFYING		Sorting or ordering objects or ideas into groups based on their likenesses or differences
COMMUNICATING		Sharing the results of investigations

Using science process skills in teaching young children helps provide a meaningful context for learning new vocabulary and facts. It's exciting when children begin to sprinkle their explanations with words like "diurnal" or "metamorphosis," or when they can detail the differences between amphibians and reptiles.

By highlighting process skills and related approaches to learning, such as curiosity, persistence, and creativity, we hope you become more aware of the many ways to foster them throughout each school day.

OBSERVING

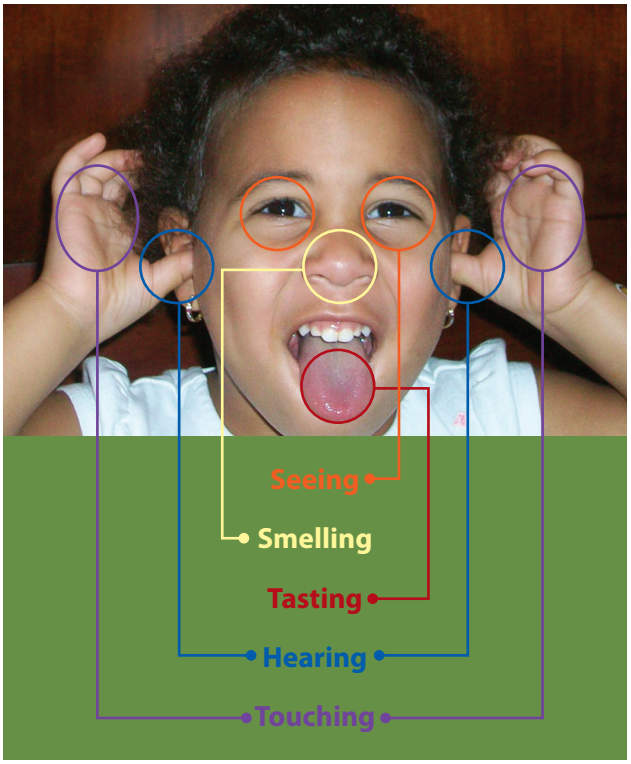
Using the Senses to Learn

Learning through the senses usually means through seeing, hearing, touching, smelling, and tasting. At birth (and even before) and throughout infancy, our earliest understanding of the world and how it works is based on our senses. Newborn babies begin discovering their worlds primarily through touch and taste. They put nearby objects or any of their own body parts they can reach into their mouths to explore the environment within their grasp.

Observation is using any of your senses to increase your understanding of something. For example, wind is something that might be difficult to observe but easier to understand with information you get from your senses, such as feeling the wind on your skin, seeing the leaves skitter across the yard, or hearing the howling sound it can make.

Children are constantly observing what is going on around them. Teachers also are natural observers. Think of how well you know each child and family and how, as you provide materials for a new group experience, you already can anticipate how certain children will react. It is exactly this knowledge that makes you an excellent science teacher alongside what you already do.

Skillful learning through the senses takes practice. Consider, for example, birders who can identify bird species by the briefest bird call, plant experts who know the differences between nearly identical plants, and cooks who can list the spices in a soup after tasting it. With maturity and experience, children learn what kind of information they can get from each sense.



Here's some of what we know about using the senses:

- From the first moments of life, we learn about the world through our senses;
- Children grow more skilled at using their senses through guided practice;
- Learning through multiple senses builds rich understanding; and
- Children are able to gather information through the senses years before they understand the connection between what they know and how they came to know it.

Infants and toddlers develop the foundations for science process skills through:

- natural curiosity, such as intently watching an adult's expressions and actions or turning over a rock to see what's underneath;
- repeating actions that have an interesting effect, such as dropping a spoon from a high chair to see how many times a willing adult will retrieve it; and
- a need to explore and make sense of the world, such as trying different ways to fit a toy inside a container.

Trusting relationships with caring adults are vital to babies' and young children's willingness to explore their surroundings and are a basis for developing cognitive skills.

Everything infants and toddlers learn is within the context of the important relationships with the adults in their lives. From this foundation, infants and toddlers feel safe to explore their environment and learn about the world. Nurturing adults can foster infants' and toddlers' development in every domain, including learning about science.

In fact, infants and toddlers are continually acting like scientists. Think of a baby shaking a rattle. She may understand she can make a sound, but imagine her delight at discovering how much more noise she can make if she bangs the rattle on the floor. This may lead to the question, "How else can I use this rattle to make some noise?" She may bang it on a nearby blanket only to discover that makes less noise than just shaking it.

When caregivers see this as a scientific process of creating a question and testing answers, they can support the process with language and appropriate materials.

Head Start Child Development and Early Learning Framework Connection to School Readiness Goals

The Head Start Child Development and Early Learning Framework was created to guide Head Start programs in their curriculum planning and ongoing assessment of children's progress and accomplishments. It describes the developmental building blocks that are most important for a child's school and long-term success.

Domains including Science, Approaches to Learning, and Logic and Reasoning; actual domain elements; and many examples of children's specific abilities, knowledge, and behavior comprise the Framework. It outlines the essential areas of development and learning that are to be used by Head Start programs to establish school readiness goals for their children, monitor children's progress, align curriculum goals and experiences, and conduct program planning.

An example from the domain element Scientific Skills and Method is:

- Observes and discusses common properties, differences, and comparisons among objects and materials.

Guiding Children in Observing

Consider the following as you help children develop their observation skills:

- Observing lets us receive knowledge of the outside world through our senses;
- We can guide children to increase their observation skills and broaden their descriptions of what they see;
- Teachers need to ask questions to focus children's observations. Questions should stimulate thinking, be open-ended, and prompt children to deepen their observations and how they think about them;
- Scientific instruments and tools, such as rulers and magnifying glasses, can enhance children's observations.

How Can I Make This Happen?

Here are some tips to help you develop children's observation skills:

- Follow a baby's gaze and comment on what he might see;
- When young children touch a new texture, provide words that might describe it, such as sticky, rough, soft, or warm;
- Point out and begin conversations about things in the environment—even if it is the motion of a rocking chair, a squirrel outside the window, or the sound of running water;
- Watch children for a while before interrupting their process—a toddler poking a stick in a hole may be very involved in her own process of discovery. You can then use that interest to talk about what might have made that hole, what might be inside of it, or how deep it is;
- When children ask questions about how something works, offer to help them figure it out rather than provide answers;
- Watch children to see what their interests are and how they observe the environment;
- Introduce new and unique objects and activities. Include activities that involve changes over time, such as planting seeds, hatching butterflies, melting ice and snowballs, watching shadows move, and noticing outdoor seasonal changes or developments at a construction site;
- Take "discovery walks" around the center. Encourage children to use all their senses to explore as they walk;

- Provide children with simple science tools to enhance their observation activities, such as magnifiers, balances, scales, eyedroppers, binoculars, sieves, and rulers;
- Ask questions that challenge children to look at and think about the objects and activities around them in a more advanced way;
- Have a camera handy to capture children's discoveries.

QUESTIONS TO ENCOURAGE CHILDREN IN USING THEIR SENSES

- *What observations can you make about the ___?*
- *What do you observe first when you look at ___?*
- *Did anyone observe something different?*
- *Can anyone find a ___ that has ___? Can you tell me about it?*
- *What would you like to know about ___?*

Another approach to stimulate children's use of their senses in exploration is object-based learning. This is a hands-on approach that fosters careful observation and sensory exploration. Appendix C includes a description of this approach to exploring with young children.

Observations and Symbolic Representation

The Head Start Child Development and Early Learning Framework includes the Domain of Logic and Reasoning. Within this domain the domain element of symbolic representation is key to promoting children's use of symbols or objects to represent something else. Part of scientific discovery is sharing ideas and new knowledge with peers and adults. Children make their understanding and thinking visible through symbolic representation. That is, they use drawings, movement, and three-dimensional creations to represent people, processes, places, things, and their other observations.

It is important to give children multiple opportunities to share their scientific thinking in different ways. Observational drawing, also called representational drawing, provides valuable insight into children's thinking and is an important way for children to express themselves. It allows children to show others what they observe and know.

When children draw, they need to study the object they are depicting closely before, during, and after the drawing activity to ensure they have included everything they observed. The most important focus of the drawing should be the meaning and information it conveys, rather than the artist's drawing skills. This focus allows the teacher and children to use critical thinking skills when discussing the artwork and prevents the teacher from judging or evaluating the work.

Some of the benefits of observational and **representational drawing** are that it:

- helps develop and clarify children's ability to observe;
- provides valuable insight into children's thinking;
- allows the teacher and children to revisit the children's observations together; and
- helps children see similarities and differences between the current object and objects they drew before.

Some children as young as 18 to 24 months old begin to visualize representational drawing to demonstrate learning. Most children over 30 months old can begin to organize these various parts into a drawing. Although some children with disabilities might not be able to demonstrate their learning through drawing, consulting with an occupational therapist may help identify other ways for these children to share their learning.

In other instances, children with a disability may not use all of their senses in learning. It is important to consult with their physical or occupational therapists to ensure that sensory learning activities fit their needs. Appropriate changes might include using physical prompts or processing science concepts at a slower pace.

Engaging Families

There are countless ways for families to engage in and reinforce observation skills and sensory learning with children. Reading books together and talking about new things at home, favorite foods, the weather, similarities and difference among people, and seasonal changes are all good ways to begin. Planting seeds, going for neighborhood walks, and visiting parks, nature areas, museums, and playgrounds also offer opportunities to observe and talk about objects and activities with children. Appendix A offers several sample letters to support connecting with the family around science.

EXTENDING YOUR LEARNING

Here are some questions for you to consider about using the senses in learning:

- *What do you need to do to actively listen to children?*
- *How will active listening help you know what new materials and opportunities to offer children to scaffold, or build on, their learning?*

PREDICTING

Forming an Opinion About What Might Happen

Predicting is forming an opinion about something that might or is likely to happen in the future. Predictions are based on related knowledge and past experience. In science, the term for an educated guess is a hypothesis. A hypothesis is a prediction of a possible explanation for something unknown based on information or observations.

Early childhood science resources sometimes use "predicting" and "guessing" interchangeably. But accurate predicting is different from just guessing. Predictions are based on relevant information. We guess when we lack information.

Children begin to form expectations about the future during the earliest days of life. They come to expect that crying will bring a caregiver, milk will be warm, and moving a toy will produce a sound. Being able to make accurate predictions allows children to interact more successfully with the world around them.

In addition to related knowledge and experience, prediction requires:

- memory;
- careful observing;
- the ability to identify and use clues; and
- an ability to imagine possibilities.

The vignette below describes a very young child using prediction skills:

> Eighteen-month-old Audrey is looking at a basket full of balls. Audrey walks over to the basket, picks it up and dumps it out. At first, Audrey looks distressed to see all the balls roll away from her. She looks around, gathers the balls, and dumps the basket over again—this time she laughs in delight watching the balls roll away.

At first, Audrey does not know what to expect from that basket of balls—she may never have played with it before. Once she dumps it out, she learns dumping the basket leads to the balls rolling away. The next time she goes for the basket, she can remember what happened before—that she observed the balls roll away. Based on her memories and observations, she might predict the balls will roll away again.

Toddlers who are Audrey's age spend a lot of time **dumping things out**—imagine all they are exploring about gravity, how much things weigh, and the various properties of objects as they hit the ground. After lots of experiences with this, young children won't need to dump every basket of toys because they will have a pretty good idea of what happens when they do.

Use the word "predict" or phrases like "What do you think will happen if … ?" when you want children to share an opinion based on knowledge or experience. Be sure to follow up by asking them to explain the basis for their opinions.

Once children gain experience with a problem, they can make general observations, such as things that stick to magnets tend to be shiny. Then, through interactions with adults or more expert peers, children learn the vocabulary to fully explain their thinking.

Children can make accurate predictions before they can explain the thinking behind them. The responses that follow were offered by children asked to explain why they predicted a metal object will stick to a magnet.

- "Because I'm smart!"
- "Because it's round."
- "Because it's shiny."
- "Because it's metal.

To be able to explain their thinking, children must know how to respond to a question. The answer "because I'm smart" is a first step. Children also must learn what information in the current situation is important to the question. Children who explain that an object will stick to a magnet because it is round recognize that the proper answer to the question involves some property of the object, rather than themselves.

Age and experience make children better able to soundly justify their predictions. This ability develops over the course of early childhood.

For children beginning to learn English in addition to their home language and have little or no vocabulary to

help them understand or talk about the past or future, talk about concrete things that focus on the present.

For children with more advanced English, include opportunities for them to observe changes over time—sprouting seeds or melting snow or ice. In these instances, children can learn vocabulary that expresses predictive ideas about future events, as well as describe what happened in the recent past.

Head Start Child Development and Early Learning Framework Connection to School Readiness Goals

The domain element, Scientific Skills and Method includes an example of predicting:

- describes and discusses predictions, explanations, and generalizations based on past experiences.

Logic and Reasoning: Reasoning and Problem Solving

An example of Reasoning and Problem Solving is:

- seeks multiple solutions to a question, task, or problem.

Guiding Children in Making Predictions

Consider the following as you guide children in learning to make predictions:

- Ask questions to help children recall what they remember. Because predictions are based on prior knowledge, it is helpful for children to explore the same materials or repeat the same experience many times. Children remember better when they capture their observations using words, drawings, or models.
- Help children become careful observers by giving them enough time to explore. During exploration, draw children's attention to important clues they might overlook.
- Ask children regularly to share their reasoning; model it for them, as well.
- Remember that during early childhood, it is more important for children to practice making predictions than it is for them to predict things accurately.

How Can I Make This Happen?

Each day presents new opportunities to practice making predictions. Children can look at the sky to predict the weather. They can notice smells wafting from covered food trays to predict what's for lunch. And they can predict that if they knock down a classmate's carefully built block tower, she will be upset. Take advantage of these daily opportunities to help children become skilled at observing clues and patterns and drawing connections with what happens next.

Events that follow a sequence provide good opportunities to make predictions, be it following the steps in a recipe, or watching a bird search the grass, find a worm, fly to its nest, and return.

Fruitful Predictions

Making predictions is a key part of any investigation. An investigation of seeds is one example of this. All fruits have seeds. But the size, shape, color, and number of seeds vary widely from fruit to fruit. Some fruits—such as mangoes—have one large seed, while others, like papayas, have many small seeds.

One way to introduce children to the idea that seeds differ among fruits would be simply to show them the insides of different fruits. But with a little planning, you can create an experience that allows children to practice both observation and prediction skills.

First, gather a variety of fruits. Children should be familiar with some of the fruits so they have knowledge on which to base their initial predictions. It also would be good to have several examples of similar

fruits so children could apply what they know or learn about one item to a similar one. For example, try using different kinds of apples or pears.

By providing similar, but not identical items, you create an opportunity for a group of children to generate different predictions. For instance, some children might predict that all apples have yellowish seeds, while others might predict the color of the seed depends on whether the apple is red, yellow, or green.

Once children make predictions, and maybe even draw pictures of what they expect, you might ask how they could find out what the seeds are like. Let the children discuss and determine their best way to discover what the seeds are like. They may suggest looking in a book or asking an adult. With some prompting, you can help them see that if you cut the fruit in half, you will find the seed(s). While this works with apples and pears, some fruits have such a large seed that you have to cut around it.

The next step would be to show the children other fruits—one by one—that differ in the size, number, or color of seeds. This allows them to build understanding from repeated experiences and to apply knowledge they may have from past experiences.

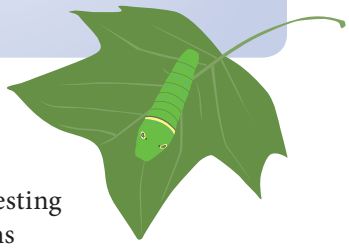
In this seed investigation, children receive immediate feedback about the accuracy of their predictions. It also is useful to engage children in longer-term investigations that take more time to yield results. Consider growing plants, for example. Older preschoolers are able to connect results with predictions much earlier, especially when they have the opportunity to observe changes on a daily basis.

You can apply the systematic approach used to explore seeds to many kinds of investigations, such as exploring bubbles or magnetism. To effectively support making predictions, the investigations should include:

- related background knowledge or observation experience on which children can base their predictions, such as reading a book;
- carefully chosen materials, which should be similar in some ways and different in others;
- opportunities for children to use the same materials in different ways, providing knowledge to support predictions;
- an adult to initially guide children's explorations so that they actually stop to make predictions; and
- learning activities to encourage children to make predictions when exploring on their own.

QUESTIONS TO ENCOURAGE CHILDREN'S PREDICTING

- *What do you think causes ___?*
- *What's going to happen?*
- *If you do this, what will happen?*
- *What do you think will happen if we do ___?*
- *Will the same thing happen every time you do ___?*



Engaging Families

To involve parents and other family members, set up interesting experiments and investigations in the classroom and ask them to make their own predictions. For example, ask them how many days they predict it will take a caterpillar to form a cocoon—or for a bean to sprout inside a desk drawer. Once parents have the idea, perhaps they will suggest other experiments, or even bring in their own.

EXTENDING YOUR LEARNING ABOUT PREDICTING

Reflect on the quote below and answer the questions that follow:

"Teachers … feel the need to grow in their competencies; they want to transform experiences into thoughts, thoughts into reflections, and reflections into new thoughts and new actions. They also feel a need to make predictions, to try things out, and to interpret them.... Teachers must learn to interpret ongoing processes rather than wait to evaluate results." —Loris Malaguzzi

- *Can you think of a prediction you made today?*
- *What did you do to test the prediction?*
- *Did you find an answer or did you need to revise your prediction?*
- *Did you change your thinking or teaching as a result of your findings?*
- *What are your potential next steps?*

INVESTIGATING

Systematically Studying Objects and Events or Activities

Investigating is a systematic study of objects and events or activities. It is defined by a question children form based on their observations—a question they want to explore further. While a specific question frames and drives an investigation, you, as a teacher, should be aware of possibilities that could emerge—new ideas, new information, new expectations, and new questions, which will lead to new discoveries.

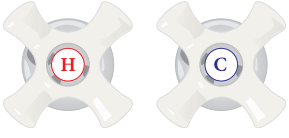
Children must observe and predict what might happen before they begin investigating. In **defining an investigation**, children try to make sense of their observations. During the next phase, or exploring phase, children develop the investigation with a teacher's help. And in the final, or reflection, phase, the children finish the investigation and share, or communicate the results.

It is possible that the investigation does not answer the children's question(s). That is okay. Try other strategies to find answers. You and the children also can identify new questions to investigate. That is what being a scientist is about.

It is important to remember that one of the goals of this guide is for children to learn to use scientific process skills effectively, not simply to learn science facts. Children actually are learning how to engage in the process of scientific inquiry and investigation. Because science is so language-rich, it is excellent for fostering language learning and vocabulary. Through scientific investigation, children who are dual language learners will gain both vocabulary and cognitive skills, such as sorting and classifying.

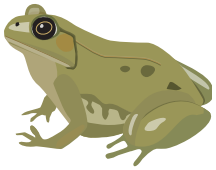
Children who are dual language learners need specific strategies to help them get the most from their learning opportunities. Plan to spend time with children individually, modeling the process of investigation.

Here are some strategies to consider when teaching children who are learning both English and their home language:



- Use real objects to introduce basic vocabulary and concepts such as heavy, light, hot, and cold;
- Pair real objects with picture cards to help children understand the picture represents a concept;
- Create small groups with children who are dual language learners and peers whose first language is English to explore science topics together;

- Incorporate nonfiction books written in children's home languages;



- Develop sequencing photo cards that show sequences of natural processes, such as tadpoles becoming frogs or caterpillars becoming butterflies;
- Label science activities and tools in children's home languages and in English and encourage them to copy the words into science journals;
- Model hands-on exploration for children by actively engaging with them in science activities and investigations.

Head Start Child Development and Early Learning Framework Connection to School Readiness Goals

Scientific Skills and Method

Examples of children's behavior that demonstrate investigating are:

- Participates in simple investigations to form hypotheses, gather observations, draw conclusions, and form generalizations; and
- Describes and discusses predictions, explanations and generalizations based on past experience.

Reasoning and Problem Solving

An example of Reasoning and Problem Solving is:

- Recognizes cause and effect relationships.

Examples of Persistence and Attentiveness in the domain of Approaches to Learning are:

- Maintains interest in a project or activity until completed
- sets goals and develops and follows through on plans; and
- resists distractions, maintains attention and continues the task at hand through frustration or challenges.

Guiding Children in Investigating

Here are some things to consider as you **help children develop their investigation skills**:

- Young children need opportunities to see, understand, and feel the object of the investigation;
- The investigation should use children's abilities to predict, persist, analyze, and reason;
- The investigation should focus on broad concepts;
- Children need to see what's happening—to look for and examine patterns, cause and effect relationships, and change over time;
- As the investigation continues, children should be able to explain what they see by describing, talking to peers and adults, **documenting, and comparing**;
- Teachers should consider what children know from sources beyond their direct experiences, such as the media, video, and technology.

How Can I Make This Happen?

There is a lot of early childhood literature about engaging children in the long-term, in-depth study of objects, events, and activities. If you are using a published curriculum or curriculum enhancement, see if there are resources on engaging in scientific investigation that you might use as an outline or blueprint.

Collecting, Organizing, Interpreting, and Sharing Data

Data help children answer questions and share their observations. Children must complete three important steps related to their data.

Step 1: Collecting. Artifacts, objects, photos, drawings, and pictures are just some examples of data children can collect. Provide them with easy access to materials to help with their data collection, such as paper, writing tools, small clipboards, and clear containers for sorting and storing objects, measuring tools, cameras, and journals.

Step 2: Organizing. Children have many options for organizing the data they collect. Among these are graphs, sequences, patterns, data tables, Venn diagrams, drawings, charts, pictographs, and maps.

Step 3: Interpreting and Sharing. Children need to share, or communicate with others, what their data mean. They can do this through conversations, drawings, simple charts, **model making**, music, and drama. While these explanations may not be scientifically accurate, it's the process children are engaging in that's important. They are learning to make predictions, conduct investigations, and gather data to check the accuracy of what they predict.

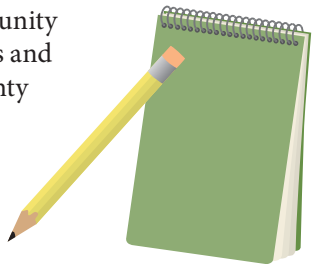
QUESTIONS TO ENCOURAGE CHILDREN'S INVESTIGATING

- *How do you think we should investigate this question?*
- *Where could we look for information about this?*
- *What are some possible solutions?*
- *How would you use ___ to ___?*
- *What do you have to do to find out if you're right or wrong?*
- *What materials will you need? What steps will you have to take?*
- *What needs to happen for your prediction to be right?*
- *How will you know if you're wrong?*
- *How will you measure it?*
- *Was your prediction right? If so, why? If not, why not?*

Engaging Families

Children love to gather data, especially about their family and home. **Engage children** in "home-schoolwork." Send home a note explaining that the children are gathering data on a certain topic, such as things you sit on, water use, types of lighting, etc. Provide paper, small notebooks, and pencils. Make sure to keep families up-to-date on the progress of the data gathering and interpretation so they can see that their help and interaction with their children are important.

Exploring the community offers children many opportunities to observe, ask questions, make predictions, and gather data. Neighborhood walks, park visits, traffic watching from the steps of their home, and grocery shopping are activities family members can do with their children. Family members can watch for special community events and contact the parks and recreation department, county extension agencies, and volunteer and information services for free programs to attend with their children.



EXTENDING YOUR LEARNING ABOUT INVESTIGATING

Looking back on an **investigation** you did with the children, think about the questions below. You may choose to discuss them with your colleagues.

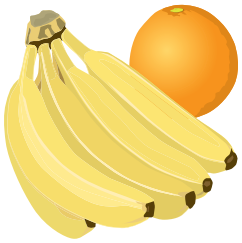
- *As a teacher, how did you facilitate the investigation?*
- *What did you do to support and extend the investigation?*
- *Are there related investigations to explore, or did the children express interest in any related investigations?*
- *How did you encourage and support children to explore and take risks as they justify their scientific thinking?*
- *What role did observational drawing play in the investigation?*

CLASSIFYING

Sorting or Ordering Objects or Ideas into Groups Based on Their Likenesses or Differences

Classifying is the process of sorting or ordering objects or ideas into groups or categories based on their similarities or differences. Children begin to form categories during their first year of life. Some categories, such as gender, are very easy to learn and some living things, like dogs, are easy to classify.

As very young children—from infancy to about age two—explore their environment, they learn to respond differently to different objects and eventually recognize these objects. This process is essential to the development of children's classification skills.



By contrast, older children will continue to explore objects and group new ones in relation to previously discovered ones. They begin to use classes or names of groups even though they really do not know exactly which objects belong to a particular class and which do not. For example, preschool children may use the class name "fruit" if they do not know the name of a specific fruit.

Other categories are more challenging. Properly classifying living things or events often takes careful study and even special tools. Sometimes, new discoveries lead scientists to change the way they classify things.

Sorting activities provide children with some of their first classification experiences. Children initially classify by sorting groups of completely different objects into what Piaget refers to as "graphic collections," using logic that only the child can understand. If given a collection of shapes to classify, the child may put a circle, a triangle, and a square together to make a figure of a person, or put a triangle on top of a square to make a house or even put one object with another "just because"—a way of looking at children's reasoning first introduced by Inhelder and Piaget (1969).

People tend to classify things they see into categories at very young ages and in all aspects of life. Even toddlers will point to a cat and say "dog." While they may not be completely correct, they have the right idea—both cats and dogs would fall into the category of "animal."

A wonderful way for adults to support this emerging skill in infants and toddlers is to label items naturally present in their environments. Simple statements

such as, "We're having peas for lunch" and "Peas are vegetables" can provide some of the foundations children will use later to create categories. Adults also can make a point of noticing when children sort objects during play by saying: "I see you chose all of the pink scarves" or "It looks like you are collecting the largest blocks you can find." Preschool children naturally sort items by size, color, or type.

Classifying is key to many fields of science. For example, scientists classify plants, animals, diseases, medicines, rocks, and minerals. Young children can go beyond physical features they see. Preschoolers classify animals and machines differently because they know they differ on the inside. Older preschoolers also consider things such as thinking and feeling when separating humans from other animals.

The ability to group objects, living things, and experiences into categories underlies concept development. The processing of this kind of information that allows us to group and compare grows more complex as children develop from early childhood on. Classification helps us make predictions, draw inferences, and communicate with others.

Head Start Child Development and Early Learning Framework Connection to School Readiness Goals

Reasoning and Problem Solving

An example of Reasoning and Problem Solving is:

- classifies, compares, and contrasts objects, events, and experiences.

Guiding Children in Classifying

The human brain is wired to organize the world into categories. The categories we form are shaped by cultural experience and brought about through language. Consider the following in relation to classifying:

- Children create categories by interacting with the world;
- Children build knowledge about the natural world through guided exploration involving a lot of conversation;
- Adults support children's ability to classify the physical world by providing opportunities to explore objects and materials with different appearances, properties, and functions. They help children notice how objects and materials are alike and different, using descriptors and labels in their discussions;
- Young children tend to focus on differences more than similarities when asked to compare;
- Children and adults use categories to make predictions, draw conclusions, and communicate with others.

How Can I Make This Happen?

The first step in classifying is to notice how things are alike and different. Encourage children to use all of their senses throughout the day to compare and contrast. Ask questions such as:

- Who is wearing shorts and who is wearing long pants?
- How does the weather today compare to the weather yesterday?
- Do the worm and the ant move the same way?

Collections are wonderful tools to support classifying skills. Children can categorize and compare and contrast natural materials including leaves, seeds, rocks, shells, and even dead insects.

Other great objects to collect and investigate include old tools and hardware that would be safe for children to explore, outgrown shoes, balls, and wheels and other parts of old toys. Be sure that anything added to the collection could not pose any harm to children by having rust, sharp edges, pinchers, or other unsafe features. If nature walks are a regular part of your classroom routine, encourage children to gather interesting objects for your collection as they walk.

Observing live animals up close helps children appreciate their unique features. Field trips to museums, farms, zoos, and aquariums also give children a chance to notice and appreciate variety within a single kind of animal or different species of birds, fish, or snakes.

Other experiences, such as a visit by a new baby, harvesting beans from the class garden, or navigating a nature walk all can build children's understanding of categories and concepts involving life stages, plant types, and different surfaces.

If living examples are unavailable, photographs and illustrations can help convey the idea of classifying to children. During all of these experiences, adult conversations guide children as they learn to classify.

Keep the following things in mind as you help children learn the science process skill of classifying:

- Create collections to support classification practice based on children's interests. For clues, carefully observe children during unstructured activities for how they use categories to organize their world. Examples you might see include choosing the same size or color or putting animals into groups of babies and parents. Also pay attention to things children bring from home to share or that they collect from the playground. Children are often big collectors of natural items and other curious objects.
- Challenge children's thinking by adding items that can be classified or that can be hard to classify. Collections are an important part of any science or discovery area. But many children lose interest if new items or collections are not rotated on a regular basis.
- Think creatively about the kinds of categories you would like children to form. Often, the collections we provide encourage sorting only by physical characteristics. Explore items children can group by function, such as tools, or their relation to a central theme, such as things related to birds or to a story.

Be alert to the tendency of some children to pair up or match items only in pairs, rather than group them. Provide uneven numbers of items to discourage them from solving classification problems by counting out groups of equal size. Listen for labels children use in everyday conversation. Do they over extend a label—perhaps calling any small living thing a "bug?" During conversation, use labels for individual categories and things—for instance, "A lady bug is an insect."

QUESTION TO ENCOURAGE CHILDREN'S CLASSIFYING

- *What do you notice about ___?*
- *How is ___ the same as___?*
- *How is ___ different from ___?*
- *Does ___ remind you of anything else you have ever seen/done?*

Engaging Families

There are many ways families can promote children's classification skills. Begin by explaining to them that many young children are natural collectors. Drawing parents' attention to the value of this activity may help them better appreciate the developmental importance of collecting, rather than viewing it as a nuisance.

Encourage families to let children share their collections with classmates. Actively enlist families to provide materials for collections, such as recycled, reused, or repurposed items. You can formalize family contributions by creating home-schoolwork projects that encourage children to bring in one or more items from home to add to a collection. Some families may have collectors. Perhaps they can make a guest visit to share their collections.

Some children with disabilities may need simple verbal instructions and detailed demonstrations to be able to successfully classify objects. Using prompts and guiding children's hands through the activity are always helpful. Peer support is a great strategy to motivate children to participate and to promote inclusion. When providing objects to children with disabilities, make sure there are obvious differences in their size, shape, and color.

EXTENDING YOUR LEARNING ABOUT CLASSIFYING

Looking back on classification experiences with the children, think about the questions below. You may choose to discuss them with your colleagues.

- *What do children have an interest in collecting?*
- *How can you extend children's classification skills by adding more complexity to sorting and classifying experiences?*
- *How many attributes can children use to classify or sort materials? How many different ways can children sort similar objects or materials?*
- *How can you encourage parents and families to support children's interest in developing collections?*

COMMUNICATING
Sharing the Results of Investigations

Communicating is essential to every part of science learning and teaching. It cuts across all of the other science process skills: children communicate to teachers and each other what they observe, predict, discover, and learn. Teachers communicate their observations to children and ask questions to spark thinking and learning.

Sharing ideas and discoveries is a key part of the scientific process. Scientists usually work in teams, whether they are in a laboratory or in the field. They communicate as they **plan investigations**, collect data, and interpret what they find. They share their work with the rest of the world by giving talks and writing up their research. Sharing ideas and interpretations often gives rise to new questions and approaches.

In focusing on communication in early childhood science, we plant the seed that science is indeed a social activity. With modeling and support, children can begin to adopt the communication practices that actual scientists use.

Communication skills children develop as they explore and discover scientific knowledge also help their language, literacy, and conceptual development. Science often involves the use of difficult words and lengthy discussions about complex interactions. Through their study of science, children can have fun learning and using big words and other important language skills, such as the ability to ask and answer questions.

Communicating thoughts through words, drawings, or three-dimensional **models** lays the foundation for developing literacy. These same activities deepen children's conceptual understanding.

Children acquiring a second language can transfer already learned words and concepts from their first language. As you work with dual language learners—and other children as well—remember to:

- Show a genuine interest in what interests them;
- Be observant. Notice how the children explore novel objects or situations and think about how to support and deepen those experiences;
- Choose a meaningful conversation topic. Their choice of a toy or play area signals their interest;
- Learn to accept and read the meaning of gestures and facial expressions, such as a nod of the head or a smile. Is a child asking for a word? Does she want to join a particular child?
- Use names of people and objects, rather than pronouns;

- Focus on the present and concrete. Use props to demonstrate the topic of discussion or the challenge or problem under study or consideration by the group.

Head Start Child Development and Early Learning Framework Connection to School Readiness Goals

Scientific Skills and Methods

Examples of Scientific Skills and Method include:

- observes and discusses common properties, differences, and comparisons among objects;
- participates in simple investigations to form hypotheses, gather observations, draw conclusions, and form generalizations;
- collects, describes, and records information through discussions, drawings, maps, and charts; and
- describes and discusses predictions, explanations, and generalizations based on past experience.

Conceptual Knowledge of the Natural and Physical World

An example of Conceptual Knowledge is:

- observes, describes, and discusses living things and natural processes.

Guiding Children in Communicating

The following concepts relate to communicating, teaching, and learning science:

- Science is, by nature, a social activity;
- The more words children hear through discussion, conversation, and narration, the more words they know;
- Children learn words most easily when they hear them used often and in many different ways;
- Representing ideas in words, drawings, and models deepens children's understanding of them.

How Can I Make This Happen?

Adult modeling and support are critical to teaching children to communicate their ideas and questions about science. Here are some ways to do this:

- Help children learn words and concepts by having them describe their own actions. As children become more verbal, encourage them to communicate their ideas by asking questions and and describing their own observations;
- Be alert to when helping children verbalize their actions might move their thinking forward;
- When working with small groups, give each child an opportunity to share his or her ideas; Restate what the children say. If you aren't sure you completely understood what a child said, ask a follow-up question;
- Some teachers find it useful to:
  - create a routine for organizing science activities to take full advantage of the communication opportunities science provides older preschoolers;
  - include an introductory phase in the routine in which children share their initial ideas, shared explorations, and conclusions about what they learned;
  - create a structured format to help you build enough time into the day to discuss science and reflect on what happened after the science activities;
  - include a discussion with or without a book during the reflective time; and
  - have children provide reports with drawings or other visuals of what they learned.

Keeping a Science Journal

A proven way to foster literacy and science learning is to have children keep **science journals**. What should they include in these journals? Observational drawings are an excellent place to start.

Begin by having children draw immobile objects. Drawing still objects allows children to learn to observe carefully as they create—and it allows you to ask questions to guide them toward improving the accuracy of their drawings. Objects with distinct parts that can be labeled, such as plants—or interesting insides, such as fruits or mechanical toys—lend themselves well to early attempts at observational drawing.

With age and experience, children grow able to represent things that may not be immediately visible, such as processes (a butterfly metamorphosis), predictions (what will happen to a plant kept in the dark), and past events (how water moved through a tube).

Children at first may not recognize the difference between representational drawing and creative storytelling or other artistic efforts. One way to help them distinguish between the two is to limit their science journal entries to scientific content and provide them a second journal for artistic work. Or you can let them choose from a variety of creative opportunities throughout the day.

Of course, scaffolding children's early attempts at journaling is also key. Focusing children's attention on important details, asking questions, and labeling drawings helps them appreciate the difference between reality and fantasy.

Remember that the conversations between children—and between children and you—about their drawings are important. They reveal a great deal about what children are thinking and help them clarify their own thoughts.

Creating a Learning Story

Another approach is to document children's comments and thinking with words and photographs that can be shared with their families. One example of this is called a **learning story**. To create a learning story, you observe a child doing something interesting and write a description of what the child says and does. You then add a reflection of what the child was doing—for example, the strategies the child used.

The next part of the learning story is called "opportunities and possibilities," which describes how the child's learning could become deeper and more complex.

Some children with limited communication skills may benefit from detailed descriptions and steps of science processes. Picture symbols and assistive technology devices may sometimes be necessary. It also is important for the children to show interest in the science materials you make available to them.

Using picture icons to promote communication has been a reliable strategy for teaching science to some children

QUESTIONS TO ENCOURAGE CHILDREN'S COMMUNICATING

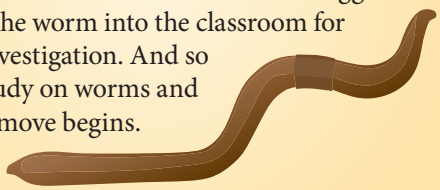
- *Anika, you said ___ about ___. The other day, I heard Ramon say ___. Could you talk to Ramon about this?*
- *Sonia, could you explain to Noah why you think ___?*
- *I saw Ricardo working on that problem earlier. Could you ask him what he did?*
- *Could you draw a picture to show how ___ works?*
- *Could you write a story about what you discovered when we walked to the lake today?*

with disabilities. Positioning a child next to a much more verbal peer also could encourage communication.

Engaging Families

Examples like the one introduced on page 12, which is reprinted below, offer a perfect chance to teach children about investigating and can involve family members as well.

> Tomás and Eva, on their way into the classroom, discover a small worm. Tomás picks it up and it begins to wiggle. Immediately, he drops it on the ground! Eva smiles as she picks it up, and places it in her hand. Together they giggle. Ms. Rodriquez, after observing the interaction, crouches beside them and suggests bringing the worm into the classroom for further investigation. And so a small study on worms and how they move begins.



Children can learn to collect data and use journals to record what they see. Family members could bring in natural objects from around their homes for children to explore or use for a science exploration day. Remember that science is natural for all learners of every age and offers a perfect opportunity to tailor learning for the children in your classroom.

Parents are often surprised to learn their young children are interested in science—and even more surprised by how much their children can understand about it. They will recognize the potential when they think about conversations they have with their children.

Observations of parents talking with young children at home and at museums have shown that children often ask questions related to physical and biological sciences (Callanan, Jipson, & Stampf Soennichsen, 2002). One recent study found that when actively engaged with an adult, three- to four-year-old children ask an average of 76 information-seeking questions an hour (Jipson & Callanan, 2003).

Other studies (Callanan & Jipson, 2001; Crowley, Callanan, Jipson, Galco, Topping, K., & Shrager, 2001) show that the explanations parents provide help build vocabulary and basic science concepts. This finding is interesting because parents' explanations usually are not entirely clear or complete. Yet the bits and pieces of information parents share each day help children build scientific understanding.

How can we help families better appreciate their children's potential for learning science? One way is to encourage them to record children's science questions in a diary over several days or to make a "question jar" to collect all the questions their children ask. On a rainy day, parents can ask children to choose a question or two that they can investigate together. Activities like these can help parents tap into children's interests and trigger efforts to answer their questions using the Internet or a trip to the library.

Hopefully, this guide has helped you think about science and how to nurture scientific discovery in the classroom in new and different ways. Refer back to this guide, the Science Webcast Series, and the MESS resources often for new ideas and sources of inspiration. Most importantly, remember that your greatest inspiration for discoveries and investigations will come from the children and their natural curiosity about all that surrounds them.

EXTENDING YOUR LEARNING ABOUT COMMUNICATING

Here are some questions for you to consider about communicating on scientific thinking.

- *What opportunities do you give children to communicate their thinking in a variety of ways?*
- *How do you help children understand that communicating what they have learned is part of the process?*
- *How do you encourage and support children to explore and take risks when demonstrating and justifying their thinking?*

APPENDICES

This appendix contains the following samples:

Appendix A: Sample Parent/Family Letters

Sample letters introducing parents and families to the process of experiencing science in Head Start

Appendix B: Responses to Frequently Asked Questions About Science in Early Childhood

Responses to questions posed by teachers about science activities

Appendix C: Object-Based Learning Discussions

Object-based learning discussions to encourage science exploration

Appendix A: Sample Parent/Family Letters

Introductory Letter to Parents/Families

Dear Parents and Families,

Do you know that when you are involved in your children's learning they can be more successful in school? Right now in Head Start, we are learning about the world through science process skills. Science process skills are basic actions children use to explore and make sense of their surroundings.

The key to science is being curious and asking questions. Children are naturally curious about the world around them. At school, we are responding to children's curiosity by focusing on the following science process skills:

- **observing**—using the senses to learn;
- **predicting**—forming an opinion about what might happen;
- **investigating**—systematically studying objects and events or activities;
- **classifying**—sorting or ordering objects or ideas into groups based on their likenesses or differences; and
- **communicating**—sharing the results of investigations.

Right now, we are investigating trees to learn why some of them lose their leaves in fall, while others do not.

You can support your children's curiosity by doing fun science activities together at home or in your neighborhood. Here are just a couple of ideas:

- Take a walk to see how many different birds live in your community. Have your children draw one of the birds and then investigate the habitats and food sources for that particular bird. Share your findings with the Head Start or Early Head Start teacher.
- Learn about recycling by tracking the items picked up by the recycling crew. This is a great investigation. Find out where the recycling truck goes and what happens next to everything on the truck. Perhaps you can visit a recycling center to learn about the recycling process first-hand.

Grown-ups don't have all the answers to children's questions, so let your children's curiosity awaken your own and investigate answers to their questions together. Your public library can be a great place to start. Good luck!

Sincerely,

Your Child's Teacher

Appendix A: Sample Parent/Family Letters (Cont.)

Sample Family Letter

Dear Parents and Families,

You are an important part of your child's school success. Helping your child practice what she learns in school is one way to provide support.

Right now, we are using our senses to learn about the world. Using the senses to observe is an important science skill. Observing can take place anywhere—at home, in the neighborhood, in the community—almost anywhere you and your child are together.

Here's something you can try no matter where you are. Say to your child, "Stop! Look! Listen!" Give her a minute to focus, and then ask her to describe what she saw, heard, and noticed. This activity can help her practice the science skills of observation and communication. She may wonder about something she sees or hears. This can be the perfect opportunity to make a discovery together. Your involvement helps her learn and understand how important science is.

Sincerely,

Your Child's Teacher

Sample Family Letter Template

Dear Parents and Families,

Helping your child practice what she learns in school is one important way to provide support.

Right now at school we are learning about _____. This began when children asked the question, "_____?"

Helping children find answers to their questions is key to learning about science. Adults will never know all the answers to the questions children ask, which is why we work together to investigate topics that fascinate children.

For example, we are doing _____ to learn about _____. You can support your child's curiosity at home or in your neighborhood by doing fun science activities together. Here are some ideas:

- Activity 1
- Activity 2
- Activity 3

You can continue your explorations with other activities you come up with, as well. Record your discoveries in a journal to share with the class.

Good luck and thank you for being your child's first teacher!

Sincerely,

Head Start Teacher and Staff

Appendix B: Responses to Frequently Asked Questions About Science in Early Childhood

Many teachers enjoy participating in science activities with young children. However, for various reasons, some teachers feel they are not teaching science as well or as often as they would like. In this section, we respond to questions and concerns and offer ideas, solutions, or suggestions we hear from infant, toddler, and preschool teachers in the field.

Question: ***I'm nervous about teaching science since it wasn't my greatest subject in school. What can I do to feel more comfortable?***

Response: **Some teachers feel limited** by their own science backgrounds. But it is their own curiosity and willingness to explore and learn alongside children that is key to helping children discover science. Consider that children learn science by examining and exploring things in their everyday world, like snails, plants, rocks, and shadows. A teacher's emphasis should be on encouraging them to expand their perceptions of these things, rather than on providing specific facts and information about them. Teachers can do this, for example, by encouraging children to: observe silkworms changing into moths; compare the smells of various foods; classify leaves collected on a walk; and communicate what they have learned. Most adults who think they do not like science actually enjoy making discoveries with children. Observing their joy and amazement is contagious!

Question: ***Do you have any ideas on how to fit more science into an already full schedule?***

Response: Young children tend to build a deeper understanding of science ideas if they can explore them in depth and over time. It actually is better to give children opportunities to explore a question over days or weeks than to explore isolated topics at weekly intervals.

One of the basic principles promoted in this guide and in the webcasts is that science is a set of processes rather than activities. This set of processes includes:

- making observations;
- asking questions;
- making predictions;
- searching for answers; and
- sharing what you learned.

These processes help teachers weave in science learning throughout the day, month, and entire year—at mealtimes, outside, during free-choice periods, and during structured activities.

Another exciting thing about science is that instead of competing with other learning goals, it supports growth and learning goals across all domains and areas of development, including literacy and mathematics. Because it involves a lot of conversation and sometimes difficult words, science fosters language development. We promote literacy development when we ask children to record what they see in words and drawings and when we incorporate books and other print materials into our investigations. Counting, sequencing, sorting, and measuring with formal and informal tools occur naturally during science exploration. Because science involves collaborating, sharing, and taking turns, it also supports social and emotional development. Practice using tools and materials promotes fine motor development. And the excitement of the exploration impacts curiosity, persistence, goal setting, and problem solving, which are all dispositions of learning.

Question: ***How or where can I find materials to enhance my children's science learning experiences?***

Response: While it's convenient to get all of the supplies you need together in one prepackaged kit, it is usually cheaper to collect supplies on your own. This ensures that you have what you need to respond to your children's natural scientific interests. There are a number of ways to increase your collection of science materials:

- First, when you have an opportunity to select materials for your center or classroom, choose high-quality, developmentally appropriate science tools. Examples of equipment recommended by early childhood science experts and teachers are included on page 15 of this guide.
- Second, "go green" by collecting safe and appropriate objects or supplies that could be reused for children to investigate rather than thrown out. See page 15 for some ideas.
- Third, look around your center or classroom for toys or play materials that you could use but that you don't typically associate with science, such as wooden blocks or small animals, different-sized cups, tissue paper, and crayons and drawing paper.

- Finally, the natural world offers endless possibilities for science exploration at little or no cost. Think about what you can do with:
  - shadows;
  - water;
  - ice;
  - snow;
  - plants;
  - changing seasons;
  - holes; and
  - feathers.

Question: ***Sometimes the children get fidgety and distracted during science discussions. How can I fully engage them in science discovery?***

Response: **Focus on the science processes** and take your lead from the children. Interestingly, research shows that when classrooms begin to focus more on science processes rather than science facts, behavior problems actually decline. Early childhood experts and teachers believe this is because children can become bored by typical classroom activities. Building on and encouraging children's interests—and exploring them—will result in more engaged learning and fewer problem behaviors.

Of course, it takes time and practice for children to learn how to properly explore science. You can take the following steps to encourage positive behavior:

- Organize and have all materials, including books, ready in advance. It is not reasonable to expect young children to wait while you gather supplies.
- Introduce materials to children slowly, making sure to model how to handle objects—especially fragile ones—appropriately.
- Work in small groups initially to help children learn to share their ideas and give each child a chance to talk.
- Listen carefully to children's ideas and ask questions along with them to draw out more information.
- Explain things simply. If you begin feeling as though you are giving a science lecture, stop.
- Comment positively when children behave appropriately.

Question: ***How can a teacher encourage children to produce a representation, rather than an arts and crafts product?***

Response: When children share or communicate their understanding of a concept, they often represent this understanding with a graphic, model, or diagram. During a representation activity, the teacher engages in the creative journey alongside the children, sharing the experience with them and using good questioning skills and reflection to guide and challenge the children in creating their representations. Not only do the children create a visual representation, they often engage in conversations that can lead to discussions about issues related to what they are representing.

Here's an example: A child drew a picture of a squirrel the class saw on a walk. The picture led to a conversation about changing seasons, why squirrels gather and store nuts, and whether or not squirrels hibernate. This experience is very different from an arts and crafts activity, where children are given collage materials and directed to assemble a squirrel.

Appendix C: Object-Based Learning Discussions

One way to help children develop their observation skills is through object-based learning. Object-based learning is a hands-on approach that promotes children's use of all of their senses to interpret objects and events and to understand their meaning. You can learn more about object-based learning by listening to Sharon Schafer from the Smithsonian Early Enrichment Center as she discusses the topic during the OHS webcast entitled **"Look What I Know. See What I Can Do!"**

Observing is one of the most important ways children learn science. From birth on, children use all of their senses to carefully process information about objects and events. Observing is one of the skills that integrates with the other science process skills to help children develop an understanding of their world. When children and teachers observe an object or event, they pay close attention to what is going on in front of and around them.

Teachers can identify children's interests, how they learn, and how they apply their observations to real situations. Written notes, photos, and video will help capture, reflect on, and interpret children's learning moments as you plan their next learning opportunity. Documenting children's learning in this way also will help you inform other staff members, parents, and families about the children's learning.

Curiosity initiates and extends the observation process. As children learn to observe, they begin to think about, imagine, and interpret what they see and are able to pay attention longer.

Children sometimes look at objects very quickly. After just a few moments, they have moved on to something else. Teachers can help children focus more carefully and consider different viewpoints by observing an object or event alongside them. Observing along with the children allows the teacher to respond to children's observations and pose questions that will prompt them to look at objects, experiences, and events more thoughtfully.

When children are carefully observing something, they may spend a long time noticing big or small differences. They also might discuss their observations with classmates. This is the kind of behavior to encourage when children are learning science.

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