California Preschool/
Transitional Kindergarten

Learning Foundations

Science

Universal PreKindergarten

For Three-to-Five-and-a-Half-Year-Old Children in Center-Based, Home-Based, and TK Settings

Table of Contents

Introduction

Young children have a sense of wonder and natural curiosity about objects and events in their environment. From infancy, they actively engage in making sense of their world.[1] They build things with blocks, roll toy cars and other objects down ramps, show interest in insects and plants, collect rocks, and play with dirt, water, and sand. Children's play and exploration have much in common with the scientific processes employed by scientists.[2] Everyday experiences provide children with many opportunities to ask questions, explore with their senses, make sense of what they observe, and build a coherent understanding of the world around them, with adults' support.[3] Research shows that children's natural inclination toward exploration and opportunities to engage in early science experiences provide a foundation for academic success in later years.[4]

The Preschool/Transitional Kindergarten Learning Foundations (PTKLF) in the domain of Science describe the knowledge and skills that young children can develop and demonstrate in their daily learning experiences. As children play and interact with others and their environment, they are constantly encountering opportunities to investigate and solve problems related to science **phenomena**. Children explore concepts related to **living things** and **nonliving things**, the weather, objects in the sky (for example, the sun, moon, and stars), and how their actions impact the environment around them. Children identify everyday problems in play and learning experiences that they solve through **trial and error** and by employing their prior knowledge. As children explore their environment, they use tools, **digital devices**, and mathematics skills to measure, document, and make sense of their observations.

The PTKLF provide guidance to all California early education programs, including transitional kindergarten (TK), federal and state preschool programs (for example, California State Preschool Program, Head Start), private preschool, and family child care homes, on the wide range of science and **engineering** knowledge and skills that children age three to five and a half typically attain

when attending a high-quality early education program. Teachers can use the PTKLF to guide their observations and set learning goals for children and plan for developmentally appropriate, equitable, inclusive practice, including how to design learning environments and create learning experiences that promote children's learning and development in the Science domain. Early education programs can use the PTKLF to select curricula aligned with the PTKLF, guide the selection of assessments aligned with the PTKLF, design and offer professional development and coaching programs for educators to support understanding and effective use of the PTKLF, and enhance preschool through third grade (P–3) continuity across learning goals and practice in science.

Organization of Science Domain

Strands and Sub-Strands

The California Preschool/TK Learning Foundations in Science are organized into strands and sub-strands that address key knowledge and skills that young children develop through high-quality early childhood science experiences.

- **Science and Engineering Practices:** This strand covers the **observation**, **investigation**, communication, and problem-solving skills that children demonstrate as they explore science phenomena, encounter engineering problems, and share their science insights during everyday play and learning situations.
- **Physical Science:** This strand covers children's investigation and understanding of core concepts related to the characteristics and **physical properties** of objects and materials, changes in objects and materials, and physical phenomena, such as sound, light and shadows, the motion of objects, and energy.
- **Life Science:** This strand covers children's investigation and understanding of core concepts related to the properties and characteristics of living things (for example, humans, animals, and plants), their **bodily processes**, growth and change over time, and **habitats**.
- **Earth and Space Science:** This strand covers children's investigation and understanding of core concepts related to the characteristics and physical properties of earth materials in the immediate environment and changes in earth, including the movement and apparent changes of natural objects in the sky (for example, sun, moon) and changes in the seasons and weather. The Earth Science strand also includes a foundation on children's awareness of the impact of humans' behavior on the environment and efforts to care for the environment.

- **Engineering, Technology, and Applications of Science:** This strand covers children's skills related to the **engineering design process** (for instance, identify a problem, plan and create solutions, and test and refine solutions) to solve problems they encounter in their play and interactions with others and their environment. This strand also includes children's use of tools, including digital devices, to meet the problems and goals they encounter in everyday situations.

While maintaining a focus on young children's experiences in early childhood, the Science domain is organized to highlight its alignment with the Next Generation Science Standards for California Public Schools, Kindergarten Through Grade Twelve, which emphasize three dimensions: science and engineering practices, disciplinary core ideas, and **crosscutting concepts**.[5] Science and engineering practices and disciplinary core ideas are reflected in the strands described above. In addition, throughout the foundations there are connections to how children explore and learn about crosscutting concepts through their science and engineering experiences. Crosscutting concepts are underlying themes, or ways of thinking, that are common to all disciplines of science. Children notice and explore crosscutting concepts through science phenomena across science disciplines.[6]

Foundation Statements

Within each sub-strand in the Science domain are individual foundation statements that describe the competencies—the knowledge and skills—that children can be expected to demonstrate in a high-quality early education program. Children develop these competencies at different times and in different ways within their home, school, and community contexts. The foundation statements are intended to help teachers identify learning opportunities they can support.

Age Levels

Age-based foundation statements describe what children may often know and be able to do as a result of their experiences and unique developmental journey in science. These statements are presented in two overlapping age ranges with full recognition that each child's development progresses over the early years with growth spurts and periods of skill consolidation in different domains at different points in time:

- An "Early Foundation" addresses knowledge and skills that children often demonstrate between three and four-and-a-half years of age.
- A "Later Foundation" addresses knowledge and skills that children often demonstrate between four and five-and-a-half years of age.

Examples

For each level of any given foundation, examples illustrate the diverse ways children may demonstrate their knowledge and skills. Examples across the Early and Later foundation levels show development over time. The first one or two examples in each foundation are aligned across the Early and Later age levels. Examples show how children may demonstrate a developing knowledge or skill as part of their everyday routines, learning experiences, and interactions with adults and peers. Examples also provide different ways in which children may demonstrate their developing skills in different contexts, whether indoors or outdoors, and in a range of activities throughout the day.

Multilingual learners possess foundational language abilities developed in the context of their relationships in their homes and communities. The use of their home language in the early education program serves as a powerful tool, supporting children's sense of belonging, bridging connections to their existing knowledge, and fostering deeper ties to their homes and communities. Examples in the home language of multilingual learners illustrate how multilingual children can further develop these foundational abilities by using their home language as part of their learning and daily interactions with peers and adults in the early education program. In instances where a teacher may not be fluent in a child's home language, various strategies can encourage multilingual learners to use their home languages, allowing them to leverage all of their linguistic capacities. To facilitate communication and understanding, the teacher can partner with staff or family volunteers who speak the child's home language. The teacher can also use interpreters and translation technology tools to communicate with families and gain insights about what a child knows and is able to do. All teachers should share with families the benefits of bilingualism and how the home language serves as a critical foundation for English language development. Teachers should also encourage families to promote their child's continued development of the home language as an asset for overall learning.

Some examples include how the teacher may support children as they progress to the next level of development in the knowledge and skills of the foundation. Teachers may ask an open-ended question, scaffold learning by making a suggestion or giving a prompt, or comment on what a child is doing. The examples should help teachers gauge where a child's development is, consider how to support their development within their current skill level, and build toward the next skill level in that foundation. Furthermore, while the examples may provide teachers with valuable ideas for how to support children's learning and development as children build their knowledge or skill in science, the examples are a small subset of all the different strategies teachers may

employ to support children's learning and development in this domain. At the end of this introduction, the section How Teachers Can Support Children's Early Science Learning offers ideas on ways to support children's learning and development in science. Additionally, callout boxes with tips and strategies for teaching are embedded throughout the foundations to guide practice in the domain.

Diversity in Children's Early Science Learning

Early science learning provides all children opportunities to explore scientific phenomena using their senses and make meaning based on their prior knowledge and experiences. Equitable science and engineering learning experiences build on children's identities and personal characteristics and the knowledge they gain from their families and communities.[7] The Science foundations are written to be inclusive of all children, including multilingual learners, children with disabilities, and children from diverse cultural and racial backgrounds. The examples illustrate several of the many ways in which children demonstrate their science and engineering knowledge and skills through a variety of modalities and means of communicating. The foundations and examples show that science and engineering learning experiences can have many entry points for children to learn and a variety of ways to communicate their understanding.

Offering children many ways to interact and communicate about science and engineering experiences allows all learners to demonstrate their science and engineering learning. Science and engineering experiences are language-rich opportunities for multilingual learners to develop their communication skills and expand their vocabulary in the languages they are learning.[8] Multilingual learners use their home languages, English, or a combination of all the languages they are learning to express what they observe and the meaning they make. Children may also demonstrate their understanding through drawing and modeling with different materials and through moving and playing.[9]

The Science domain also represents how children with disabilities may engage with science and engineering learning opportunities. The foundations have been written to support a variety of learning styles and allow teachers the flexibility to make accommodations. The accommodations will assist all students in accessing the curriculum. Foundations and examples illustrate how offering a multitude of ways to communicate knowledge and ideas allows children to fully participate in science and engineering learning experiences. Children who require accommodations to display mastery of the foundations can use different forms of communication, technologies, or adaptive equipment to share their science and engineering knowledge and skills. They may

use verbal language, nonverbal gestures, sign language, a picture exchange communication system, or an electronic assistive technology communication device. Children may make observations through touch, smell, or sound and may demonstrate their observations by pointing or gesturing, expressing joy or enthusiasm, or focusing their attention on a scientific phenomenon or engineering problem. Children with disabilities may need additional support and adaptations to demonstrate the foundations, such as modifying objects so they are easy to grasp and manipulate, using visual cues (for example, picture cards), and modeling. For children with disabilities, teachers should reference the Individualized Education Program (IEP) and regularly communicate with a child's IEP team to assist in making accommodations. The examples provided in the foundations highlight the individuality of each child and show how a range of children, including children with disabilities, can demonstrate the knowledge and skills described in the foundations.

Early science learning can provide many opportunities for children to apply their prior knowledge and connect with their families' and communities' ways of knowing. Strong connections between early education programs and children's homes and communities help make science experiences meaningful and authentic for children and allow them to use all of what they know as they discover science and engineering.[10] The Science foundations underscore the importance of the connection between children's cultural and racial knowledge and learning experiences. Their cultural and racial experiences can enhance how children engage in **scientific inquiry** and engineering practices. For example, different cultures may have different norms around question asking, and young children may follow different norms regarding how and when they ask questions.[11] Children from Native nations and tribal communities may draw on their interactions with nature, cultural practices, and communal ways of knowing as they learn about scientific concepts.[12] Teachers have an important opportunity to observe children and connect with families to understand how children's cultural and racial experiences can strengthen exploration and learning.

How Teachers Can Support Children's Early Science Learning

> "Teacher " refers to an adult (for example, lead teacher, assistant teacher, child care provider) with responsibility for the education and care of children in an early education program, including a California State Preschool Program, a TK program, a Head Start program, other centerbased programs, and family child care homes.

Science and engineering learning in early childhood involves inquiry-based, playful approaches.[13] Children thrive in learning environments that are rich with resources where they can actively explore objects and materials through their senses and hands-on manipulation (for example, playing at the water table or sandbox). Children **compare and contrast** the features of objects, notice **cause and effect** relationships, and can carry out investigations supported by adults (for example, exploring the needs of plants). Science learning is meaningful when teachers make relevant connections between science and engineering concepts and children's prior knowledge and home experiences.

Explorations During Routines and Everyday Interactions

There are countless opportunities, indoors and outdoors, for children to experience, investigate, and discuss science. Teachers can identify the everyday places and situations that allow children to directly experience science phenomena. Whether children notice the change in seasons, become interested in the differences between various fruits at snack time, or notice their shadow on a walk, teachers can take everyday opportunities to engage children in explorations and conversations about science and engineering phenomena.

Engaging Environments and Varied Learning Materials

Learning environments with varied learning materials (for example, everyday objects, natural materials, books, and tools for observation, measurement, and **documentation**) promote children's exploration and first-hand experience of scientific phenomena and concepts. The materials and resources in the environment should represent diversity in languages, race, culture, and gender. Tools should allow children with varying abilities to engage in science and help make connections between science and engineering and children's daily life.[14] Materials should also support children in communicating their understanding through varied means of expression and representation.

Opportunities for Investigations and Home Connections

Through open-ended questions and investigations, teachers can engage children's curiosity and follow their interests while offering modeling, prompting, and scaffolding to help make learning personally meaningful and support every child's exploration of science and engineering.[15] By observing children closely, teachers can draw on children's questions and interests to set up opportunities for **experiments** and investigations and for children to practice their science and engineering vocabulary.

Families and community spaces (for example, parks, playgrounds, museums, libraries, community gardens) can be resources to support playful, inquiry-based science experiences.[16] By building open, two-way relationships with families and community members, teachers can learn how to connect children's lived experiences with science and engineering learning in meaningful ways. Teachers can invite families to bring materials and objects from home for exploration that may have a special meaning or are part of their cultural practices. Family members can also help lead or participate in activities that have special meaning (for example, gardening practices, cooking activities, or outdoor explorations).

Endnotes

1 National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators* (Washington, DC: The National Academies Press, 2022); Laura Schulz, "Finding New Facts; Thinking New Thoughts," *Advances in Child Development and Behavior* 43 (December, 2012): 269–294; Laura Schulz, "The Origins of Inquiry: Inductive Inference and Exploration in Early Childhood," *Trends in Cognitive Sciences* 16, no. 7 (July, 2012): 382–389.

2 Alison Gopnik, "How Babies Think," *Scientific American* 303, no. 1 (July, 2010): 76–81; Alison Gopnik, "Scientific Thinking in Young Children: Theoretical Advances, Empirical Research, and Policy Implications," *Science* 337, no. 6102 (September, 2012): 1623–1627; Daryl B. Greenfield, Alexandra D. Alexander, and Elizabeth Frechette, "Unleashing the Power of Science in Early Childhood: A Foundation for High-Quality Interactions and Learning," *Zero to Three* 37, no. 5 (May, 2017): 13–21; Corinne Zimmerman and David Klahr, "Development of Scientific Thinking," in *Stevens' Handbook of Experimental Psychology and Cognitive Neuroscience* (4th Edition), edited by Simona Ghetti and John T. Wixted (New York, NY: John Wiley and Sons, Inc., 2018).

3 Lucia French, "Science as the Center of a Coherent, Integrated Early Childhood Curriculum," *Early Childhood Research Quarterly* 19, no. 1 (March, 2004): 138–149; Maria Fusaro and Maureen C. Smith, "Preschoolers' Inquisitiveness and Science-Relevant Problem Solving," *Early Childhood Research Quarterly* 42 (March, 2018): 119–127; Rochel Gelman et al., *Preschool Pathways to Science: Facilitating Scientific Ways of Thinking, Talking, Doing, and Understanding* (Baltimore, MD: Paul H. Brookes Publishing Company, 2010); Hope K. Gerde, Rachel E. Schachter, and Barbara A. Wasik, "Using the Scientific Method to Guide Learning: An Integrated Approach to Early Childhood Curriculum," *Early Childhood Education Journal* 41, no. 5 (September, 2013): 315–323; Amy Shillady, ed., *Spotlight on Young Children: Exploring Science* (Washington, DC: National Association for the Education of Young Children, 2013); Rachel A. Larimore, "Preschool Science Education: A Vision for the Future," *Early Childhood Education Journal* 48 (February, 2020): 703–714.

4 Andres S. Bustamante, Daryl B. Greenfield, and Irena Nayfeld, "Early Childhood Science and Engineering: Engaging Platforms for Fostering Domain-General Learning Skills," *Journal of Research in Education Sciences* 8, no. 3 (September, 2018): 144; Douglas H. Clements and Julie Sarama, "Math, Science, and Technology in the Early Grades," *The Future of Children* 26, no. 2 (2016): 75–94; Elisabeth R. McClure et al., *STEM Starts Early: Grounding Science, Technology, Engineering, and Math Education in Early Childhood* (New York, NY: The Joan Ganz Cooney Center at Sesame Workshop, 2017).

5 California Department of Education, *Next Generation Science Standards for California Public Schools, Kindergarten Through Grade Twelve* (Sacramento, CA: California Department of Education, 2013).

6 Greenfield, Alexander, and Frechette, "Unleashing the Power of Science in Early Childhood."

7 National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators*.

8 National Academies of Sciences, Engineering, and Medicine, *English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives* (Washington, DC: The National Academies Press, 2018).

9 Christina Siry and Anna Gorges, "Young Students' Diverse Resources for Meaning Making in Science: Learning from Multilingual Contexts," *International Journal of Science Education* 42, no. 14 (September, 2020): 2364–2386.

10 National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators*.

11 Maureen Callanan et al., "Children's Question-Asking Across Cultural Communities," in *The Questioning Child: Insights from Psychology and Education*, edited by Lucas Payne Butler, Samuel Ronfard, and Kathleen H. Corriveau (Cambridge, UK, 2020): 73–88; Mary Gauvain and Robert L. Munroe, "Children's Questions in Social and Cultural Perspective," in *The Questioning Child: Insights from Psychology and Education*, edited by Lucas Payne Butler, Samuel Ronfard, and Kathleen H. Corriveau (Cambridge, UK, 2020): 183–211.

12 Ananda Marin and Megan Bang, "'Look It, This Is How You Know:' Family Forest Walks as a Context for Knowledge-Building About the Natural World," *Cognition and Instruction* 36, no. 2 (April, 2018): 89–118.

13 Shira May Peterson and Lucia French, "Supporting Young Children's Explanations Through Inquiry Science in Preschool," *Early Childhood Research Quarterly* 23, no. 3 (July, 2008): 395–408; Gurupriya Ramanathan, Deborah Carter, and Julianne A. Wenner, "A Framework for Scientific Inquiry in Preschool," *Early Childhood Education Journal* 50 (October, 2022): 1263–1277; Stephanie Sisk-Hilton, "Science, Nature, and Inquiry-Based Learning in Early Childhood," in *Nature Education with Young Children: Integrating Inquiry and Practice*, 2nd ed., edited by Daniel R. Meier (New York, NY: Routledge, 2020).

14 Early Childhood STEM Working Group, "*Early STEM Matters: Providing High-Quality STEM Experiences for All Young Learners*, Policy Report, (Chicago, IL: University Chicago, 2017); Victoria Waters et al., "A Guide to Adaptations," The STEM Innovation for Inclusion in Early Education ($STEMI^2E^2$) Center (2022).

15 California Department of Education, *California Preschool Curriculum Framework*, Volume 3 (Sacramento, CA: California Department of Education, 2013); Larimore, "Preschool Science Education"; Victoria Waters and Chih-Ing Lim, "A Guide to Asking Open-Ended Questions," The STEM Innovation for Inclusion in Early Education (STEMI2E2) Center (2021); Victoria Waters et al., "A Guide to Teaching Practices," The STEM Innovation for Inclusion in Early Education (STEMI2E2) Center (2022).

16 Bustamante, Greenfield, and Nayfeld, "Early Childhood Science and Engineering"; National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators; McClure et al., STEM Starts Early: Grounding Science, Technology, Engineering, and Math Education in Early Childhood.*

Preschool/Transitional Kindergarten Learning Foundations in the Domain of Science

Children communicate their science knowledge and skills in a variety of ways, both verbally and nonverbally. Their communication may include verbal ways of communicating in their home languages, the language of instruction, or a combination of languages, or through the use of augmentative and alternative communication devices. It may also include nonverbal ways of communicating such as drawing and modeling with different materials or expressing through movement, actions, or role-play.

Crosscutting Concepts

Crosscutting concepts are underlying themes, or ways of thinking, that are common to all disciplines of science. Children notice and explore crosscutting concepts as they learn about science phenomena across science disciplines. Multiple crosscutting concepts can be explored within one science topic. Connections to crosscutting concepts appear within relevant foundations below to help illustrate how children explore these concepts as they are developing their understanding in different content areas. The connections to crosscutting concepts in the foundations are not exhaustive and are meant only as examples of different instances in which children may encounter them in their science explorations. Teachers can identify instances in which children are engaging with the crosscutting concepts through their play, everyday activities, or planned investigations. Teachers can help children deepen their understanding by using books to introduce the crosscutting concepts, asking children to describe their observations, and inviting children to express their ideas about the crosscutting concepts through various means of communication.

Crosscutting Concepts*

Preschool children can explore and understand the following crosscutting concepts:

- Patterns: Events, processes, and structures repeat in ways that can be observed, described, and used as evidence.
- Cause and effect: Certain actions lead to specific reactions.
- Scale, proportion, and quantity: Things differ in size and quantity.
- Systems and system models: Things are made of parts that work together and interact as organized systems.
- Structure and function: How things are built and/or structured determines what they can do and how they do it.
- Stability and change: Some things change, and some things stay the same. Some changes are reversible, other changes are not.

*The Next Generation Science Standards (NGSS) also include *energy and matter* as a crosscutting concept. While young children begin to notice phenomena related to energy and matter (for example, noticing that warmth from the sun melts an ice cube), the scientific concepts of energy and matter are abstract and are not explicitly addressed until third grade in the NGSS. The Science foundations include children's early awareness of sources of energy and explorations of physical materials and objects that serve as the foundation for children's learning about energy and matter in later years.

Strand: 1.0 — Science and Engineering Practices

Sub-Strand — Observation and Investigation

Foundation 1.1 **Making Observations**

Early 3 to 4 ½ Years	Later 4 to 5 ½ Years
Observe and actively explore objects and events using their senses and describe their observations.	Observe and actively explore objects and events using their senses and describe their observations in greater detail.

Early Examples

■ A teacher invites children to explore the taste and texture of different fruits with their senses and asks, "What do you notice about the fruits?" A child comments, "I call it 'piña' [pineapple in Spanish]. It's so sweet." A child with a visual impairment describes how the fruits feel, "This one is smooth [peach]. This one has spikes [pineapple]."

Later Examples

■ A teacher invites children to explore the seeds of different fruits with their senses and asks, "What do you notice about the seeds?" One child comments, "The peach has a big seed. The papaya has lots of little seeds." Another child adds, "Let's plant the seeds to see them grow."

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.1 **Making Observations**

Early
3 to 4½ Years

Early Examples (continued)

● A child observes and describes the textures of shells that were brought into the classroom by cultural coordinators.* The child expresses, "This one is soft and smooth. This one is rough."

A Deaf child observes a cylinder rolling down the slide and signs "fast" in American Sign Language, calling the attention of a peer to show how fast the cylinder is rolling.

* Cultural coordinators give guidance as reflective partners in the process of creating tribally appropriate curriculum and learning experiences and support individualized teaching that all children deserve and need to thrive.

Later
4 to 5½ Years

Later Examples (continued)

● A child shakes a rattle** and describes, "I can hear something inside. It sounds like rain." Another child shares, "It's made from a deer hoof. It has dried beans inside."

A child with a language impairment draws a picture of the praying mantis inside the terrarium. The teacher models words, and the child nods their head "yes" and says, "Praying mantis." The child indicates the praying mantis is behind a green leaf, and the teacher responds, "Yes, it is camouflaging behind the leaf."

A teacher invites a child to observe a picture of a caterpillar closely and to draw a picture of a caterpillar in their science journal. The child communicates in their home language, "It has stripes—yellow, white, black, yellow, white, black—like a pattern."

**Rattles are used by some Native nations and tribal communities in California, such as the Luiseño tribe, to accompany song and maintain cadence.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.1 **Making Observations**

Early
3 to 4½ Years

Later
4 to 5½ Years

Early Examples (continued)

A teacher invites a child to observe the inside and outside of a pumpkin by using different senses and describe how it looks, smells, and feels. The child communicates in their home language, "It has many seeds. It is soft inside."

Later Examples (continued)

Observing a snail closely, children describe it. One child acts out the snail moving slowly. Another child touches the snail and comments, "The body is very soft. The hard shell protects it." A third child describes, "It has two long pointy things [antennae] sticking out."

Crosscutting Concepts

When children explore and make observations about objects and events, they are likely to make connections to crosscutting concepts. They notice size, proportion, and quantity (for example, the size and number of seeds in different fruits). Children also make observations related to structure and function (for example, a snail's body looks very soft and its hard shell protects it) and patterns (for example, a caterpillar's stripes are yellow, white, and black). Another crosscutting concept that is likely to arise in children's explorations and observations is stability and change (for example, changes in weather conditions).

Foundation 1.2 **Comparing and Contrasting**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Compare and contrast objects and events and describe similarities and differences based on observable properties.	Compare and contrast objects and events based on physical properties and functions and describe similarities and differences in greater detail.

Early Examples

■ As the teacher bounces different balls, they invite children to listen and compare the different sounds the balls make. When the teacher asks, a child points to a ball that makes a loud sound and then to a ball that makes a soft sound.

● While watching a video about amphibians, a child contrasts a frog and a toad and describes their observation to a peer in Mandarin, “Frogs are green. Toads are brown.”

While playing in the dramatic play area, a child picks up a doll and comments, “My doll is Black. Your doll is White.”

Later Examples

■ A teacher invites children to bounce different balls to observe which one bounces higher. Then the teacher asks children to draw what they observed. A child makes a drawing showing that the smooth ball bounced higher than the ball with spikes. The child describes to the teacher, “Both are small. This one bounces higher.”

● A child contrasts a butterfly and a caterpillar by drawing them using an easel and a thick crayon. The child makes the butterfly and caterpillar different shapes and different colors.

When a teacher facilitates a plant investigation, a child observes the plants and comments, “This one [indicating the one watered] is bigger. The leaves are green. But this one did not grow. The leaves are yellow and soft. It looks dead.”

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.2 **Comparing and Contrasting**

Early
3 to 4½ Years

Early Examples (continued)

A teacher invites children to explore the inside and outside of a watermelon and asks, "What do you notice? How is the inside different from the outside?" One child shares, "The outside is green, and the inside is red." Another child comments, "The outside is hard, and the inside is mushy."

A teacher invites children to explore different cups of water and tell which is colder. A child dips their finger in the different cups of water and places a dot sticker on the cup with colder water.

When looking at different kinds of bracelets, a child communicates, "This one is made of seeds. This one is made of seashells."

Later
4 to 5½ Years

Later Examples (continued)

A teacher sets up an exploration and asks children to notice how objects that can roll down a ramp (for example, balls, marbles, wheeled toys, cups, cans) differ from objects that cannot roll down (shovels, blocks, books). Referring to objects that can roll down, a child describes, "These are round and can roll.

A teacher reads children a book about stringed instruments from around the world and asks children to describe the similarities and differences they observe. Children share their observations: "The ukulele is small." "The cello is big and you play it with a bow." "This one [*erhu**] has two strings. This one [banjo] has four strings."

*The *erhu* is a Chinese two-stringed bowed musical instrument.

Crosscutting Concepts

When children compare and contrast objects and events, they are likely to notice differences in size, proportion, and quantity (for example, a ukulele is small and a cello is big). Children compare and contrast based on structure and function (for example, noticing that things that roll are round and things that do not roll are not round). Children also make observations about stability and change (for example, plants that are watered are bigger and green and plants that are not watered are yellow and soft and look dead).

Foundation 1.3 **Asking Questions**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Demonstrate curiosity and raise simple questions about objects and events in their environment.	Demonstrate curiosity and an increased ability to formulate specific and detailed questions about objects and events in their environment.

Early Examples

■ When playing in the block area, a child stacks more and more blocks and communicates that they want to find out how tall the tower can get without falling down.

● A child picks up a ladybug and asks, "Where are the wings?"

A teacher takes children outside to explore shadows and asks, "What do you notice?" A child notices their shadow on the sidewalk and communicates to the teacher, "Look, *mi sombra* [my shadow in Spanish]! Why is it following me?"

Later Examples

■ When playing in the block area, a child creates a sloped ramp with blocks and rolls different toy cars down the ramp. The child asks a peer, "Which will go more far? Your car or my car?"

● A child sees a worm while digging in the mud and asks, "Is that their home? Do they live in the ground?" Another child asks, "What happens when it rains? Does it drown?" A third child observes the worm and asks, "Does it have eyes? How does it see to move?"

On the playground, a child looks up and asks the teacher, "Why are the clouds gray? Is it going to rain?"

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.3 **Asking Questions**

Early
3 to 4½ Years

Early Examples (continued)

A child with a disability gestures to a peer to join them in observing how the class guinea pigs eat their food. The child points on a communication board to the photo of a child eating and then points to the guinea pigs.

Later
4 to 5½ Years

Later Examples (continued)

On a nature walk guided by the teacher in the preschool yard, a child points to animal footprints on the ground and shares, "When I go on hikes with my uncle, we look for animal prints. What animal makes this shape?" The teacher responds, "Maybe together we can figure out which animal makes it. Let's bring the book on animal footprints from the classroom." The teacher and child look through the classroom book and identify that the footprint is likely made by a squirrel.

Crosscutting Concepts

Children's curiosity and questions can relate to any of the crosscutting concepts. Children may wonder about structure and function (for example, how a worm knows where to go without eyes), cause and effect and patterns (for example, noticing clouds and wondering whether it will rain based on what they have noticed in the past), or stability and change (for example, expecting a change in weather).

Approaches to Learning — The above foundation is similar to Approaches to Learning foundation 1.1 on curiosity and interest. Both domains intentionally include foundations on children's active exploration and asking questions. In Science, this foundation describes children's curiosity about events and objects in their environment that leads to their investigation of scientific questions and phenomena.

Foundation 1.4 **Defining Problems**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Identify problems during play and everyday interactions and try simple solutions on their own or in collaboration with peers and adults.	Identify problems during play and everyday interactions and try multistep solutions on their own or in collaboration with peers and adults.

Early Examples

■ While collecting toys to play at the water table, a child has trouble holding all the toys at once. The teacher notices and asks the child, "What can you use to carry all the toys?" The child grabs a bucket to carry them.

● A child attempts to build a block tower, but the blocks keep toppling over. When the child asks the teacher for help, the teacher suggests placing larger blocks at the bottom and smaller blocks at the top.

Later Examples

■ While playing at the water table, a child builds a dam to keep all the fish on one side. The child uses large plastic cubes to build the dam. When the child notices that there are still some gaps in the dam, the teacher asks, "What else can you use to fill those gaps?" The child starts filling the gaps with small plastic cubes.

● Children use chairs and cardboard to create a pretend airplane in the dramatic play area. A child who uses a wheelchair suggests they clear the floor of any toys, make a wide door, and leave a large space open so they can board the plane too.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.4 **Defining Problems**

Early
3 to 4½ Years

Early Examples (continued)

A child observes a peer trying to fit two train tracks together and suggests that they flip one track around to see if it fits better.

Later
4 to 5½ Years

Later Examples (continued)

In response to the teacher's question, "How do you think we can take better care of our plants?" a child suggests that they move the plants near the window for sunlight and ask different children to water them each week.

Crosscutting Concepts

Problem-solving provides an opportunity to observe children thinking about and working with crosscutting concepts. For example, when identifying problems and figuring out solutions, children work with structure and function; scale, proportion, and quantity (for example, using larger blocks on the bottom of a tower to create a stable structure or adjusting space to accommodate a peer's wheelchair); and stability and change (for example, noticing a change in plants when moving the plants near the window).

Foundation 1.5 **Making Predictions**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Make simple **predictions**, give simple reasons for their predictions, and, with adult support, check the predictions through concrete experiences.	Make more detailed predictions drawing on prior experiences and observations, create plans with adult support to check predictions, and demonstrate an emerging ability to discuss why predictions were correct or incorrect.

Early Examples

- A teacher asks children to make a prediction about how far a toy car will travel down a ramp. A child indicates the distance they predict with a gesture and pushes the car down the ramp to test the prediction.

Later Examples

- A teacher asks children to predict whether a toy car will travel farther down a ramp on the tile floor or the carpet. A child predicts that the car will go farther on the floor and explains, "Yesterday the car goes far on the floor. The carpet is too fuzzy. The floor is smooth."

(continued on following page)

Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.5 **Making Predictions**

Early
3 to 4½ Years

Early Examples (continued)

- When asked by the teacher to make a prediction about what will happen if they mix the water with red, a child points to a cup with red liquid, then tests their prediction by adding food coloring to a glass of water.

While exploring ceramic bowls and baskets that children brought from home, a child makes a prediction about which object will be heavier. The teacher shows the child how to use a balance scale to test this prediction.

Later
4 to 5½ Years

Later Examples (continued)

- While following a recipe to make roti,* the teacher asks the children, "What do you think will happen if water is added to the flour?" One child predicts, "The water and the flour will mix together. The flour will feel sticky." Another child adds, "Like making acorn mush!** Pour water in. Let's see what happens."

The teacher and children place some planted sunflower seeds near the window and others in the closet to see which seeds will grow. A child draws a picture predicting that the seeds near the window will grow, but not the ones in the closet. When the seeds in the closet don't grow, the child explains, "Those didn't get so much sun."

*Roti (also known as chapati) is a type of round unleavened flatbread made of wheat flour that is common throughout Southeast Asia.

**Historically, acorn mush was a food staple of California Native nations and tribal communities and continues to be a part of some tribes' meals and culture. It is made from acorn flour and water.

(continued on following page)

(continued)

Foundation 1.5 **Making Predictions**

Early
3 to 4½ Years

Early Examples (continued)

A child predicts in Tagalog that the worm will move if it is touched. The teacher replies, "Let's touch the worm gently and see what it does."

Later
4 to 5½ Years

Later Examples (continued)

The teacher sets up an investigation and asks children to make predictions about items they believe will sink and items they believe will float. The children put objects in the water and observe what happens. They provide explanations for what they observe: "The rock is heavy, so it sinks." "The bark is light, and it floats."

Crosscutting Concepts

When children make predictions and give reasons for their predictions, they will often draw on their knowledge of structure and function (for example, cars travel farther on smooth surfaces than on fuzzy ones or different types of items float or sink). They refer to their knowledge of cause and effect (for example, plants that do not get sunlight will not grow). They will also draw on their knowledge of stability and change (for example, water changes color with food coloring, when water is added to flour, it gets sticky).

Foundation 1.6 **Planning and Carrying Out Investigations**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Carry out simple experiments or investigations, on their own or in collaboration with peers and adults, to test their ideas about their observations.	Carry out more complex experiments or investigations, on their own or in collaboration with peers and adults, with greater persistence. Use observations and results of prior explorations to generate new questions and test their **hypotheses**.

Early Examples

■ A child mixes yellow and blue paint to see what new color they can create. When the teacher says, "I wonder what other colors you can create," the child brings out other paint tubes and starts mixing them.

● The teacher reads a book about shaved ice desserts that are eaten in different countries and supports children in making their own ice cones. Then the children leave the cones outside to see how long it will take them to melt.

Later Examples

■ A child remembers that mixing red and blue paints makes purple paint and wonders what will happen if they add white paint. The teacher acknowledges the child's wondering, saying, "That's an interesting question—let's find out," and brings out the white paint container. The child keeps adding white paint to see how it gets lighter and then wonders how the color will change if they add black paint.

● With help from the teacher, children test whether ice cubes will melt faster outside or inside. Then they test whether ice cubes outside will melt faster in the sun or in the shade.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.6 **Planning and Carrying Out Investigations**

Early
3 to 4½ Years

Later
4 to 5½ Years

Early Examples (continued)

A child tests how many small objects they can stack on top of each other and balance before the pile topples over.

A child wonders what it will feel like to mix kinetic sand and playdough. After mixing the two, the child explains, "Now the sand feels sticky and gooey."

A child experiments with different-sized balls to see which ball will go farther down a ramp.

Later Examples (continued)

A child tests whether they can create shadows on the wall by shining a flashlight on different objects. The child notices that the shadows are very light and asks the teacher whether they can close the blinds to make the room darker "to see the shadows better."

After a classroom parent shares about different types of beans and how they are eaten around the world, children plant different beans and observe how each one grows. They check the beans weekly and draw their observations in their journals.

Crosscutting Concepts

When children investigate and test hypotheses, they often engage in thinking about cause and effect and patterns. The content of their explorations can relate to crosscutting concepts such as structure and function (for example, rolling different-sized balls) and stability and change (for example, testing how long it will take an ice cone to melt or what will happen if they add black paint to their existing paint).

Foundation 1.7 **Using Tools**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Identify and use some observation and **measurement tools**, with adult support.	Identify and more spontaneously use a greater variety of observation and measurement tools, with some adult support.

Early Examples

■ While exploring the class collection of rocks, a child uses a magnifying glass, with the teacher's assistance, to observe the rocks more closely.

● A child refers to the measuring tape and shares with their teacher that they used a measuring tape with their auntie when they made a bird feeder at home.

Using a measuring cup, a child helps the teacher measure two cups of water to make watermelon juice. The teacher asks the children, "What do you call watermelon at home?" Children share the word in different home languages.

In a soil investigation, a child with a physical disability uses an adaptive shovel provided by a teacher to collect soil in the yard.

Later Examples

■ While exploring the class collection of rocks, a child brings a scale from the shelf to weigh the different rocks.

● Fascinated with the growth of their green beans, a child picks up a ruler from the shelf and communicates, "I want to see how big it is." The teacher responds, "Great idea. Let's check how *tall* it is."

While investigating different types of local plants, the teacher offers different tools for children to use. A child with low muscle tone uses a magnifying glass fitted with a bigger grip to look closely at sage leaves.

A child uses an eyedropper provided by the teacher to add the right amount of water to the clay to soften it to make a bowl with it.

■● Matching icons indicate alignment of examples across age-ranges

Supporting Children's Observation and Investigation Skills

Teachers can support the development of observation and investigation skills by creating environments where children are encouraged to ask their own questions and plan and carry out investigations. Teachers can:

- Establish a climate where children feel comfortable asking questions, trying new things, and making mistakes. When children have questions, teachers can model how to look for more information when they do not know the answer. For instance, a teacher might respond, "That's an interesting question. I'm not sure, but we can look for a book that will help us learn more."
- Create a physical environment that sparks children's curiosity and scientific inquiry by providing different types of materials they can explore, including everyday objects, natural materials, and scientific tools. Centers with natural materials, books, or loose parts that children can explore freely can spark children's curiosity and new scientific explorations.
- Provide opportunities for children to engage in scientific investigations inspired by their interests and questions in collaboration with peers. For example, if children encounter challenges with balancing blocks to build a tall tower, a teacher can introduce a series of explorations that help children investigate balance.
- Plan a range of science and engineering investigations that build on children's discoveries over time and enable children to deepen their scientific understandings. For instance, when learning about castles, teachers can invite children to use recycled materials to build their own castles that are stored safely at the end of the day so children can add to them over a series of days.
- Ask open-ended questions that invite children to describe and make meaning of their observations and explorations without teachers assuming a specific response. Using prompts such as "Why do you think that happened?", "What do you think will happen next time?", or "Can you say more about that?" invite children to describe their understanding.

Sub-Strand — Documentation, Analysis, and Communication

Foundation 1.8 **Documenting Observations and Using Models**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Record observations or findings with adult support and use simple representations, including drawings, models, movement, role-play, and other methods, to convey their observations and understanding of science concepts.	Record observations or findings in greater detail with some adult support and use more elaborate representations, including drawings, models, charts, diagrams, movement, role-play, and other methods, to convey their observations and understanding of science concepts.

Early Examples

- With support from the teacher, a child observes the weather and uses picture cards to record on a group chart whether it is sunny, rainy, or windy outside.
- Following their teacher's guidance, children represent plant growth by imitating the teacher physically scrunching down, then standing up, then spreading their arms and hands.
- After examining a dragon fruit, a child draws a red oval with lines that look like spikes and many dots inside. The teacher writes down the child's observation: "It is red and spiky outside. Soft inside with lots of seeds."

Later Examples

- With support from their teacher, children prepare a book with drawings, photos, and charts of the weather they recorded throughout the year.
- Following their teacher's guidance, children create and act out a story of farmers growing strawberries. They act out raking the soil, planting the seeds, watering the plants, and harvesting the strawberries.
- A child with fine motor difficulties draws a picture using a pencil with an adaptive grip of a leaf they observed and then dictates a description to the teacher: "The leaf is yellow and has a lot of lines."

(continued on following page)

■ ● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.8 **Documenting Observations and Using Models**

Early
3 to 4½ Years

Early Examples (continued)

During a walk around the neighborhood, a child uses a digital camera with the help of a teacher to document what they observe (for example, rocks, leaves of different colors, insects).

A child makes a drawing of the dirt mound and ants they observed while playing in the outdoor space.

Later
4 to 5½ Years

Later Examples (continued)

During circle time, a child collects information on chart paper with the help of the teacher, making tally marks to record how many children in the class have pets and how many do not have pets.

After coming back from a walk around the rancheria,* a child creates a model of different buildings they observed using various materials, such as boxes of different sizes, paper rolls, and plastic bottles.

*A rancheria is a Native American land base in California.

Crosscutting Concepts

Children can show their exploration and understanding of different crosscutting concepts as they document their observations and use models. They can show their explorations of stability and change (for example, representing plant growth) and patterns (for example, recording weather over time). They can represent systems (for example, an ant colony or a neighborhood) as they document and model their observations.

Foundation 1.9 **Mathematical Thinking and Analyzing Data**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Use **mathematical thinking** to analyze and quantify their observations and answer questions that arise in everyday activities, with adult support.	Use mathematical thinking with greater precision to analyze and quantify their observations and answer questions that arise in everyday activities, with some adult support.

Early Examples

■ While looking through a book of different animals with a child, the teacher asks, "How many legs do zebras and giraffes have?" The teacher and the child count the legs together by pointing to each leg. The child then communicates, "They have four legs!"

● A child refers to their notebook in which they have pasted drawings of the moon over the last week with their teacher's help and shares, "Full moon that day. Looks like a circle," while indicating the drawing of a full moon.

A child reviews the class chart of languages spoken by children. The teacher asks, "How many languages do our friends speak?" The child responds that there are three different languages spoken. The teacher responds, "Yes, three languages: Spanish, Vietnamese, and Arabic."

Later Examples

■ When looking at photos of different animals with a child, the teacher asks how many legs each animal has. The child counts on their own and communicates, "Ostriches have two legs. Elephants have four legs. And ladybugs have six legs!"

● A child refers to a book the teacher is reading and points to a rock, saying, "Look, the rock looks like a triangle—one, two, three sides!"

After an investigation of fruits and vegetables introduced and facilitated by the teacher, a child explores a chart created with other children that depicts foods that have seeds inside and foods that do not. When asked by the teacher, the child concludes in their home language, "Fruits have seeds and vegetables do not."

■● Matching icons indicate alignment of examples across age-ranges

Foundation 1.10 **Formulating and Communicating Explanations and Solutions**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Formulate and communicate simple explanations and solutions during play and collaborative investigations.	Formulate and communicate more detailed and precise explanations and solutions during play and collaborative investigations.

Early Examples

■ Building a tower with blocks, a child explains, "First I put the big blocks and then the small blocks. Now it doesn't fall."

● After a child notices that a magnet was repelled by another magnet, the teacher asks, "What happened?" The child explains, "This one is running away from this one." The teacher responds, "Yes, this magnet was repelling the other magnet."

When asked by the teacher what plants need in order to grow, a child with autism indicates on a communication tablet the photo of a child drinking water.

Later Examples

■ A child draws a tower with big blocks at the bottom and small blocks at the top and dictates to a teacher, "First, I had big blocks at the top. My tower fell. The big blocks were too heavy. Then, I put the big blocks at the bottom, and my tower did not fall."

● After noticing that a magnet was repelled by another magnet, a child explains, "My sister told me that magnets repel each other. That's fun." They then play with magnets attracting and repelling each other.

During a group discussion facilitated by the teacher about what is needed to grow, a child shares, "We need food. The food goes into our stomach and helps our body grow."

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 1.10 **Formulating and Communicating Explanations and Solutions**

Early
3 to 4½ Years

Early Examples (continued)

A child explains to a peer in Cantonese, "You can make bubbles by adding soap with water. I did that with my sister."

When building a marble run, a child suggests, "We can move the track up. The marbles will go far."

Later
4 to 5½ Years

Later Examples (continued)

A child explains using a mix of English and their home language that in the book they read in their group, they learned that lizards camouflage in the desert to blend into their surroundings.

During a group investigation introduced and facilitated by the teacher, a child makes a clay model of the different phases of the moon and dictates to the teacher in Arabic, "When the moon is full, it looks like a circle, and when it gets small, it looks like a smile."

Crosscutting Concepts

When children formulate and share their explanations and solutions, they can indicate their understanding of crosscutting concepts. They may refer to their understanding of stability and change (for example, communicating about the different phases of the moon or about making a tower stable) or cause and effect (for example, noticing that one magnet repels another magnet).

Supporting Children's Documentation, Analysis, and Communication

As children engage in scientific investigations, they can also document their observations, analyze data, and communicate their findings and new understanding. Teachers can:

- Provide a variety of materials and tools that children can use to document and share their observations and solutions. Children can use writing and coloring supplies, stamps and stickers, notebooks, or recycled materials (like cardboard) to create models. They can also use digital cameras or audio recorders to document what they notice.
- Invite children to represent and communicate their scientific ideas, explanations, and design solutions through drawings, models, movement, role-play, and other methods. For example, when exploring the growth of plants, teachers can facilitate a dramatic representation of the growth from seed to plant.
- Facilitate activities where children quantify their observations by supporting them in sorting and classifying data and identifying patterns that help answer their questions. For instance, in an exploration of rocks, children can sort rocks that are rough or smooth. Or children can help document the pattern of the phases of the moon. Children can use their mathematical skills to answer questions that are of interest to them based on data or observations they have recorded. **Classification** and patterning are mathematical skills essential to learning and organizing information in science.

Strand: 2.0 — Physical Science

Sub-Strand — Properties and Characteristics of Nonliving Objects and Materials

Foundation 2.1 **Characteristics of Objects and Materials**

Early 3 to 4 ½ Years	Later 4 to 5 ½ Years
Investigate and describe the characteristics and physical properties of objects and solid or nonsolid materials (for example, size, weight, shape, color, texture, smell, and sound).	Investigate and describe in greater detail the characteristics and physical properties of objects and solid, liquid, or gas materials (for example, size, weight, shape, color, texture, smell, and sound).

Early Examples

■ A child digs in the sandbox and expresses, "The sand is hot over there [in the sunlight], but here [in the shade] it is cold."

● A child with low vision participates in making a collage using materials of different textures (for example, sandpaper, paper, cloth, ribbons, rocks, sand, feathers) and describes each material, "The sandpaper feels rough. The ribbon feels smooth."

A child holds a wood block and a foam block and indicates the wood block when the teacher asks which one is heavier.

Later Examples

■ A child digs in the sandbox and expresses, "The sun is hitting the sand over here. It's hot. This other side is in the shade, and it feels cold."

● During show-and-tell, a child describes the characteristics of the object they brought from home. "It is small, round, and smooth. It bounces. You can play with it." The group guesses that it's a bouncy ball.

A child blows with a straw on different objects (for example, a pencil, a piece of paper, a ball, a feather, a leaf) and tries to make them move. With assistance from the teacher, the child glues pictures of the objects on either side of a large piece of paper to record which objects moved and which did not.

(continued on following page)

■ ● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 2.1 **Characteristics of Objects and Materials**

Early
3 to 4½ Years

Later
4 to 5½ Years

Early Examples (continued)

A teacher puts out materials for children to create different kinds of instruments. While filling an egg shaker, a child discovers that filling it with sand makes a softer sound and filling it with pebbles makes a louder sound. The child comments, "The sand is slow," and sways slowly, then says, "The pebbles are fast," and dances exuberantly.

A teacher encourages children to explore different objects that sink and that float while playing in the water table outside. A child puts a leaf in the water and communicates in their home language, "The leaf is not going down." Then the child puts a marble in the water and comments in English, "This one goes down."

Later Examples (continued)

Working with modeling clay, a child notices its similarities to playdough and communicates in their home language, "It is soft, and you can make different things with it just like with playdough. But you have to press it hard with your fingers."

A teacher invites a child with a language impairment to sort objects such as wood blocks, paper, clear plastic cups, and aluminum foil based on whether they are opaque or transparent. The child demonstrates that they can see through a plastic cup by holding the cup up to their eye and saying, "I see you." The teacher replies, "Yes, you can see me through the cup. The plastic cup is transparent."

Crosscutting Concepts

Investigations of nonliving objects and materials lend themselves to discussions of cause-and-effect relationships (for example, different materials inside maracas cause different sounds, or sunlight causes the sand to get hot) and structure and function (for example, describing the characteristics of items that sink or float, or learning that transparency allows one to see through an object or material).

Foundation 2.2 **Light and Sound Waves**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Notice and explore sound, light, and shadows using their senses and by manipulating objects and materials during play and collaborative investigations.	Explore and describe changes in the properties of sound, light, and shadows by manipulating different objects and materials during play and collaborative investigations.

Early Examples

- A child points to their shadow on the sidewalk and then comments to their peer, "Look, my shadow. And your shadow."
- A child communicates to their teacher, "Listen. Sounds like an ambulance."
- A child explores how to create a shadow of their hand on the wall by using a flashlight.
- A child plays a steel drum* that was brought in by a family member, listening closely to the sounds made on different parts of the drum.

* A steel drum (also known as a steelpan) is a percussion instrument that originated in Trinidad and Tobago.

Later Examples

- With prompting from their teacher, children explore how their shadow gets bigger and smaller as they move closer to and farther from a light source. One child expresses, "Look, my shadow gets so big!"
- A child notices that the sound of an ambulance changes as it gets closer and then farther away. The child communicates to the teacher, "The ambulance sound was loud and then soft."
- A child shines a flashlight through different-colored transparent tiles to see how the color of the light changes.
- While listening to a song through a speaker, a child who has a visual impairment covers the speaker with their hand and then takes their hand off repeatedly to explore how the sound changes. The child describes, "I can make it loud, then soft, loud and soft."

■● Matching icons indicate alignment of examples across age-ranges

Crosscutting Concepts

As children explore sound, light, and shadows, they are likely to show that they are thinking about scale, proportion, and quantity (for example, noticing the size of a shadow in relation to its distance from the light source). They also show that they are playing with stability and change as they manipulate aspects of a situation to make changes to shadows or sounds (for example, changing the size of a shadow or the pitch or volume of a sound). Structure and function also come into play as children explore the different sounds, light, or shadows made by objects of varying shapes, sizes, and materials.

Sub-Strand — Changes in Nonliving Objects and Materials

Foundation 2.3 **Exploring Changes in Objects and Materials**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Explore and describe changes in objects and materials using their senses (for example, change in color, shape, texture, temperature) during play and collaborative investigations.	Explore, describe in greater detail, and explain changes in objects and materials using their senses (for example, change in color, shape, texture, form, temperature) during play and collaborative investigations.

Early Examples

- A child participates in making mesquite cakes* with the help of the teacher and describes how they can make the dough by adding water to the mesquite pod flour.
- A teacher facilitates an exploration of melting ice. A child notices that the ice in the cup melted into water. The child puts their fingers in the water and gestures to the teacher to come over and feel the water.

*Mesquite cakes are made from mesquite tree pods that are ground into flour. They are known as a food source in Southern California Native nations and tribal communities such as the Cahuilla tribe.

Later Examples

- A child participates in baking a cake with the help of the teacher and describes that the batter was gooey and runny and then turned into a fluffy cake after being in the oven.
- A teacher facilitates an exploration of melting ice. A child with low grip strength uses a pencil with an adaptive grip to draw in their journal how the ice in a bowl melted from the morning to after lunch and describes, “The ice was very small. There was water in the bowl. It melted.”

(continued on following page)

Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 2.3 **Exploring Changes in Objects and Materials**

Early
3 to 4½ Years

Early Examples (continued)

At a painting easel, a child mixes red paint and yellow paint and shares, "Look, it turned orange."

While playing with clay, a child comments to their peer, "Let's make a tortilla,"* then begins flattening the clay with the palm of their hand. The peer pokes holes in it using their finger, then smooths it out again and expresses, "It's flat again."

After the teacher adds soap to the water table, a child points to the soap and communicates in Arabic, "Put more soap. Pleeease! I want more bubbles!"

*A tortilla is a type of round unleavened flatbread from Mexico and Central America made of corn or wheat flour.

Later
4 to 5½ Years

Later Examples (continued)

In response to the teacher's question about what would happen if blue powder were added to water, children predict, "The water will turn blue." "The water and the paint will mix together, and it will be blue paint."

When checking the clay they rolled the day before for a necklace, a child explains, "We left it out all night. It's hard now."

When helping the teacher make vegetable rolls using rice paper,** a child comments, "I make these with my mommy. The rice paper gets soft in the water."

** Rice paper is a thin translucent edible paper made from rice flour and tapioca flour used in Vietnamese cuisine.

Crosscutting Concepts

As children explore how different objects and materials change, they learn about stability and change. For example, children may notice that ice cubes melt when they are exposed to the heat of the sun or that cake batter changes state due to a change in temperature. Children also explore cause and effect as they create changes through their own actions (for example, mushing a banana by pressing it with a fork or mixing red and yellow paint to get orange).

Foundation 2.4 **Force and Motion**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Observe and describe the way objects' speed and direction change and explore the effect of their own actions (for example, pushing, pulling, rolling, dropping) on making objects move or stop during play and collaborative investigations.	Make and test predictions about how objects change direction, speed, or the distance they go and, based on their observations, explain why objects start, stop, or change direction or speed during play and collaborative investigations.

Early Examples

■ During a class investigation introduced and facilitated by the teacher, a child blows through a straw on a table tennis ball and observes the ball move. The child expresses that the ball moved fast when they blew hard.

● A child puts blocks in a wagon and asks their peer for help. "It's very heavy. Can you help push it up the hill?"

A child notices the effect of changing the direction of the handlebars when riding a tricycle and shares, "Look, teacher. When I go like this [turns the handlebars right], I go that way. When I turn it this way [turns left], I go the other way."

Later Examples

■ During a class investigation introduced and facilitated by the teacher, a child rolls a table tennis ball on the grass and then on the sidewalk. They explain that the ball went farther on the sidewalk because "the sidewalk is flat."

● A child pulls a wagon around the yard and then goes up a small hill. At the top of the hill, the child expresses to their peer, "I can give it a little push and the wagon will go down, down, down."

When playing in the block area, a child creates a sloped ramp with blocks and rolls different toy cars down the ramp. The child asks a peer, "Which will go more far? Your car or my car?" After rolling the cars, the child explains, "Mine went more far because I pushed it hard."

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 2.4 **Force and Motion**

Early
3 to 4½ Years

Later
4 to 5½ Years

Early Examples (continued)

A child demonstrates to peers how they can push their wheelchair down the ramp.

A child plays with an electric train and describes in Cantonese how it moves. "It starts here and goes around and around like this. And then comes back."

Later Examples (continued)

While rolling balls down the slide, a child refers to the steeper slide and communicates using a mix of English and their home language, "This one is faster. Look how faster this ball rolls down."

Crosscutting Concepts

As children explore force and motion, they learn about cause and effect. For example, they notice that kicking a ball hard or changing the incline of a ramp changes how far a ball rolls. They explore systems and system models, for example, when they notice how the parts of a bike work together to set or change its direction or speed. They also explore structure and function, as they notice how different characteristics of objects and the environment influence how they move (for example, a ball goes farther on the sidewalk compared to on the grass).

Foundation 2.5 **Energy**

Early
3 to 4 ½ Years

Demonstrate awareness, with adult support, that things (living and nonliving) need sources of energy to function.

Later
4 to 5 ½ Years

Demonstrate awareness, with adult support, of the different sources of energy that things (living and nonliving) need and describe the changes they observe as a result of these sources of energy.

Early Examples

■ When the teacher asks what plants need in order to grow, a child explains that plants need sunshine to grow and adds, "Grandma tells me stories about the sun and plants that she learned from her mother."

● When the teacher asks what people need in order to live, a child shares, "My mommy says that I need to eat so I can be strong."

Later Examples

■ During an investigation into what plants need in order to grow, a child observes the changes in a plant by the window and a plant in a dark part of the room. After several days, the teacher asks, "What happened to the plants?" A child responds, "The one that got sun grows. The other one didn't. It needs the sun!"

● When the teacher asks about what people need in order to live, a child shares, "My *abuelita* [grandmother in Spanish] told me that we need to eat so our body will have energy and we can run and play. Animals also need to eat to be strong."

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 2.5 **Energy**

Early
3 to 4½ Years

Later
4 to 5½ Years

Early Examples (continued)

While playing in the dramatic play area, a child pretends that their play phone is out of battery. The teacher asks, "What does your phone need?" The child responds, "I need to charge it."

Later Examples (continued)

When the teacher asks what cars need in order to go, a child describes that their older brother taught them that some cars need gasoline and others need to be plugged into electrical outlets.

After the teacher reads a book about different sources of renewable energy, a child makes a drawing of wind turbines. The child dictates to the teacher, "The fans turn with the wind. They help make energy for our houses."

Crosscutting Concepts

Thinking about energy provides opportunities for children to learn about systems and system models. For example, they might describe that wind moves turbines, which creates energy for homes. They might know that some cars need gas to move while others are different and require being plugged in. Cause and effect are also likely to be part of children's explorations of energy (for example, when they notice that the sun's warmth causes crayons to melt or that sunlight is necessary for plants to grow).

Supporting Children's Explorations and Learning in Physical Science

Children learn about the physical world through active exploration of objects and materials. As children build with blocks, play with different balls, and explore water, sand, and clay, they form ideas about the physical properties of those things. Teachers can:

- Provide children with opportunities to explore a variety of objects and materials (such as balls, magnets, watercolors).
- Plan and guide children in investigating different physical phenomena (for example, light and shadow, sound, motion, balance, cooking activities) through planned, open-ended explorations over multiple days or even weeks. For instance, teachers can plan for children to investigate light and shadow over a series of days, starting with children exploring their own shadows outside, then seeing how they can create shadows using flashlights and how the light changes when shining light through a prism, and even telling stories using shadow puppets.
- Invite children and their families to bring materials and objects from home for exploration that may have a special meaning or are part of their cultural practices. Family members can also help lead or participate in activities that have special meaning (for example, gardening, cooking activities, outdoor explorations). For instance, family members who practice subsistence farming can share how they tend to their crops, how they deal with the changing weather, or how they are mindful of their impact on the environment.

Strand: 3.0 — Life Science

Sub-Strand — Properties and Characteristics of Living Things

Foundation 3.1 **Characteristics of Living Things**

Early 3 to 4 ½ Years	Later 4 to 5 ½ Years
Identify and describe characteristics of a variety of animals and plants, including appearance (inside and outside) and behavior, and demonstrate an emerging ability to categorize them.	Identify and describe characteristics of a greater variety of animals and plants and demonstrate an increased ability to categorize them.

Early Examples

■ A child observes and identifies the characteristics of a ladybug and, when prompted by the teacher, shares their observation with others, "The ladybug is very small." The child records their observation of the ladybug by drawing a picture in their journal of what it looks like.

● On a nature walk in the outdoor space, children identify short plants and tall plants. One child points to a pinyon pine and communicates, "That's a big tree. The leaves are so spiky." When they return to the classroom, the teacher shares with children that Native nations and tribal communities in California, such as the Kumeyaay, use the pinyon pine needles to weave baskets and the seeds (or pine nuts) as food.

Later Examples

■ A child observes and identifies the characteristics of a ladybug and, when prompted by the teacher, shares their observations with others. "The ladybug is round and has tiny legs. It has black dots." The child records their observations of the ladybug by drawing a picture in their journal of what it looks like.

● On a nature walk in the outdoor space, children identify the different plants they observe. One child points to a flower and identifies the different parts, stating: "That's the flower petals, and the stems, and the leaves. The roots are under the dirt." When they return to the classroom, the teacher reads the children a book about the different parts of plants.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 3.1 **Characteristics of Living Things**

Early
3 to 4½ Years

Early Examples (continued)

After the teacher cuts open a variety of fruits to show children the different numbers of seeds inside, a child begins to recognize that fruits have seeds. When the teacher asks what is inside an apricot, the child communicates in their home language, "A seed."

A child looks at an informational book in the reading corner and identifies which animals can fly.

A child observes a cactus and tells a peer, "My grandma has some of those in her yard. They have needles. I got poked once."

Later
4 to 5½ Years

Later Examples (continued)

With the teacher's prompting, a child sorts fruits, such as mangoes, avocados, apples, grapes, peaches, and apricots, based on whether they have one seed or many seeds inside. The child points to the avocado and the apricot and communicates in Mandarin, "Look! They both have one big seed."

During circle time, a child shares that one night they heard coyotes and that "sometimes my dog also sounds like a coyote."

When the teacher leads a discussion about plant roots that we eat, different children communicate different things, such as "potatoes," "taros," and "yams."

A child contrasts butterflies with moths and describes that butterflies are more colorful and have bigger wings.

Crosscutting Concepts

As children explore the characteristics of a variety of animals and plants, they notice scale, proportion, and quantity to describe and categorize them. For example, children may use relative scales to describe animals and plants, such as bigger and smaller or faster and slower. Children also consider structure and function when they notice how the characteristics of plants and animals are related to the ways they behave (for example, animals that have wings can fly, or the needles of a cactus can poke you).

Foundation 3.2 **Bodily Processes**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Indicate emerging knowledge of bodily processes (for example, eating, sleeping, breathing, walking) in humans and other animals.	Indicate greater knowledge of bodily processes (for example, eating, sleeping, breathing, walking) in humans and other animals through more detailed observations and descriptions.

Early Examples

■ The teacher asks a child about the senses associated with different body parts (for example, eyes for vision, ears for hearing). The child pinches their nose and communicates, "Now I can't breathe."

● A child points to a picture of an elephant in a book and tells another child, "Big poop! 'Cause they eat so much!"

A child places their hand on their stomach and shares, "At home, I ate some peach cobbler! My tummy almost popped!"

After running, a child touches their chest to feel their heart beating.

A child describes in Arabic how their new sibling "sleeps all the time because he is still a baby."

Later Examples

■ The teacher asks a child about the senses associated with different body parts (for example, eyes for vision, lungs for breathing). The child puts their hands over their chest and communicates, "My big sister said that my heart pumps blood through my body."

● A child points to a picture of a caterpillar and explains to another child that when a caterpillar eats, the food goes to its stomach and then it poops.

When using a stethoscope in the dramatic play area, a child tells another child, "Look. When I breathe, my chest goes in and out."

When the teacher asks what is inside the body of a hen, a child describes that there are blood, bones, and a heart inside.

A child explains in their home language, "We can walk with our legs, and birds fly with their wings."

■● Matching icons indicate alignment of examples across age-ranges

Crosscutting Concepts

Knowledge of bodily processes is related to children's growing awareness that our bodies are systems. For example, children develop an understanding that animals have body parts arranged into systems that help them process food and get energy. Children also consider cause and effect when connecting eating to pooping, or the effect of pinching one's nose on the ability to breathe. Structure and function are highlighted when children think about how legs and wings relate to different forms of locomotion or how noses and chests (lungs) relate to breathing.

Foundation 3.3 **Living and Nonliving Things**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Expect **animate objects** (people and animals) to self-initiate movement and to have different insides and biological processes that make them behave differently from **inanimate objects**.	Indicate knowledge of the difference between living and nonliving things and recognize that only living things (people, animals, plants) undergo biological changes such as growth, illness, healing, and dying.

Early Examples

- While in the yard, a child points to a roly-poly and expresses, "It is a real one! Look, it's moving."
- When the teacher asks whether a toy cat can eat, a child replies, "No. It has a mouth, but it's not real. It has soft stuff inside."
- While wiggling a wooden snake at their teacher's leg, a child communicates, "It won't hurt you, teacher; it's not real."
- While observing a snail, a child comments to another child, "It only looks like a rock, but it has a head and moves."
- A child communicates in Tagalog, "My puppy is going to get big, but this one [showing a toy] won't."

Later Examples

- While in the yard, a child points to a roly-poly and expresses, "This roly-poly is alive. It looks like a little ball when I hold it in my hand. When I put it on the ground, it starts moving."
- When the teacher asks whether the toy baby rabbit will grow, a child replies, "It's just pretend. It can't grow like a real rabbit."
- A child shares with their teacher, "My puppy is sick. We took her to the vet to check her heart and bones. The doctor gave her medicine."
- A child explains that a toy puppet can't really grow or get sick "because it's not real. We just pretend it's sick when we're playing."
- A child communicates in their home language that plants need sunlight and water to grow or they will die and adds, "Fake plants don't die!"

■ ● Matching icons indicate alignment of examples across age-ranges

Crosscutting Concepts

As children distinguish between living and nonliving things, they relay their growing understanding of systems and system models (living things have systems that keep their hearts and bones healthy) and cause and effect (for example, plants need light and water to grow and will die without them). When they describe that living things grow but nonliving things don't, they are reasoning about stability and change in different kinds of objects.

Foundation 3.4 **Heredity and Traits**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Name and describe similarities and differences they observe between grown animals, including humans, and their young ones.	Express their expectation that young animals and plants will reflect similar characteristics to grown animals and plants of the same kind.

Early Examples

■ While listening to a book about animals read by a teacher, a child points to a horse and shares, "This is the papa horse, and this is the baby horse. They look the same. But the papa horse is big, and this one [pointing to the baby] is small."

● While playing with toy farm animals, a child matches a calf and an adult cow and describes in Spanish, "This one is the baby" (indicating the calf).

A child shares with the teacher, "My baby sister has light skin like my mommy. I have brown skin like my daddy."

A child with a disability points to the shell of a baby turtle and then to the shell of a grown turtle in a picture book. The teacher responds, "Yes, both have hard shells." Using their communication tablet, the child communicates "baby" and "daddy."

Later Examples

■ While listening to a book about animals read by a teacher, a child points to a chick and shares, "The chick will look like the big chicken when it grows up" (indicating a grown chicken on the next page).

● While playing a matching game, a child turns over a card of a baby grizzly bear and comments, "I know what card I'm looking for. The mama bear is also brown but bigger."

A child sees a young palm tree recently planted in the yard and communicates, "This one looks like the tall palm trees, but it's small right now. I think it will grow very tall like the ones near my house. Those have dates."

A child communicates in their home language, "Look at the kitty. It looks like the big cat my neighbor has. It's the same, but the kitty is a baby."

■● Matching icons indicate alignment of examples across age-ranges

Crosscutting Concepts

When children think about **heredity** and **traits**, they are noticing patterns (for example, adult animals and plants are larger than baby animals and plants). Children also reason about stability and change as they describe how **offspring** grow and change over their lives and how certain traits continue over generations (for example, baby grizzly bears share the coloring of their parents).

Foundation 3.5 **Habitats**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Identify the habitats of people and familiar animals and plants and communicate their understanding that living things have different habitats.	Recognize that living things have different habitats suited to their unique needs.

Early Examples

■ After the teacher facilitates a discussion about places where people live, a child draws a picture of her home and describes who lives in it: "Mommy, Mom, and me."

● A child shares that on their trip to go camping in the desert, they saw many cactuses.

On a walk around the neighborhood, the teacher directs a child's attention to a bird nest. The child communicates in Cantonese, "Birds live there!"

Later Examples

■ After the teacher facilitates a discussion about places animals live, a child draws a spider in its web and explains, "The web is the spider's home and is sticky to catch food."

● A child shares that on their trip to visit their grandparents, who live in the desert in Mexico, they saw many cactuses. The child explains, "Cactuses live in the desert. They can live with not a lot of rain. And they have a yummy fruit called *tuna* [prickly pear in Spanish]."

With support from the teacher, a child sorts the photos of animals according to those that live in water, those that live on land, and those that can live both in water and on land.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 3.5 **Habitats**

Early
3 to 4½ Years

Later
4 to 5½ Years

Early Examples (continued)

While playing in the outdoor space, children come across a dirt mound. A child attempts to step on it, but another child comments, "Don't step on it. Ants live there."

In the sandbox, a child creates a well with water and places a toy fish, a whale, and a shark in it and acts out the sea animals swimming around.

Later Examples (continued)

A child colors a flamingo in a pool of water and explains in their home language, "Flamingos need to be in the water. That's where they get their food."

After a demonstration by the Environmental Protection Agency, a child describes to the teacher that they learned about protecting and respecting the land where animals, plants, and humans live.

Crosscutting Concepts

Structure and function are likely to come up as children learn about habitats. They might note how a spiderweb helps the spider catch food or how the shape of a nest allows it to hold and protect eggs. They will likely notice patterns, such as animals with fins living in the water, while those with hooves live on land.

Sub-Strand — Changes in Living Things

Foundation 3.6 **Growth, Change, and the Life Cycle of Living Things**

Early 3 to 4 ½ Years	Later 4 to 5 ½ Years
Observe and explore growth and changes in humans, animals, and plants and communicate an understanding that living things change over time in size and other capacities as they grow and age.	Observe and explore growth in humans, animals, and plants and communicate an increased understanding that living things change as they grow and age. Describe transformations related to an individual's **life cycle** (for example, birth, growth, reproduction, death).

Early Examples

■ During a classroom investigation introduced and facilitated by the teacher, a child is fascinated by how the silkworms spin their cocoons and asks, "How do they turn into cocoons?"

● After reading the picture book *The Tiny Seed*, the teacher asks, "What happened to the tiny seed?" A child answers, "It grew into a flower."

After planting okra seeds with the help of the teacher, a child predicts, "The seeds will grow. There will be yummy okra to eat."

Later Examples

■ During a classroom investigation introduced and facilitated by the teacher, a child observes a tub of silkworms and exclaims, "Look, one of the worms molted!" while pointing at the silkworm's molted skin shell.

● After reading the picture book *The Tiny Seed* with the teacher, a child pretends they are a seed and demonstrates with their body how a little seed can grow into a seedling and how the seedling can grow into a tree.

The teacher asks children's families to bring children's baby photos to the classroom. During circle time, children share their baby photos and show how they have grown and changed.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 3.6 **Growth, Change, and the Life Cycle of Living Things**

Early
3 to 4½ Years

Early Examples (continued)

A child communicates in Mandarin, "Teacher, I'm big now. I can turn on the light."

Looking at a picture book, a child explains, "This is the horsey when it was a baby, and then it growed to be big," indicating a picture of a bigger horse.

Later
4 to 5½ Years

Later Examples (continued)

A child observes tadpoles closely and communicates in Spanish, "They are big. Later the legs will come out. They will be frogs."

Fascinated with the growth of the larvae (caterpillar) in the room, a child comments, "Oh, these are bigger. Maybe we should give the small ones more food."

Crosscutting Concepts

As children learn and communicate about growth and aging in living things, they use their understanding of stability and change (for example, noticing and communicating about their own growth and the changes they observe in animals and plants).

Foundation 3.7 **Needs of Living Things**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Recognize that animals and plants require care and show an emerging understanding that feeding and watering support the growth and survival of humans, animals, and plants.	Describe the needs of humans, animals, and plants for growth and survival (for example, food, water, sleep, sunshine, shelter).

Early Examples

■ In an experiment with plants facilitated by the teacher, a child observes one of the plants and communicates, "Teacher, this one needs water."

● While looking at the class hamster, a Deaf child notices the food tray is empty, points to the hamster, and communicates using American Sign Language that the hamster needs food.

Referring to a storybook read by the teacher, a child explains in Arabic, "The caterpillar ate a lot of leaves and became a butterfly."

A child communicates using a mix of English and their home language that they "saw elephants where my auntie lives. They drink a lot of water."

Later Examples

■ In an experiment with plants facilitated by the teacher, a child describes their observations: "The plants near the window grew. The plants with no light are yellow. I hope they don't die."

● A child feeds the class pet fish, with the teacher's assistance, and explains, "We give special food just for fish. But we don't give it too much."

When the teacher asks children to show what birds need, a child uses mixed materials to make a bird's nest. The teacher comments, "Birds need a nest as their shelter."

After listening to a story about the foods and traditions of the Shasta people in California, a child responds, "I eat salmon* too. Makes me grow strong."

* Salmon is a common food for California Native nations and tribal communities, including the Shasta.

■● Matching icons indicate alignment of examples across age-ranges

Crosscutting Concepts

When children consider the needs of living things and how these needs contribute to their growth and survival, they are using their understanding of stability and change. Children also think and talk about cause and effect as they connect food, water, and other needs to growth, good health, and life itself.

Supporting Children's Explorations and Learning in Life Science

Children's learning in life science is about building their understanding of the characteristics and properties of the natural world and living things, including humans. Children's explorations in life science also nurture their appreciation for the natural world and living things. Teachers can:

- Plan activities related to the natural world, such as going on a neighborhood walk to collect different leaves, searching for bugs or other small animals in the yard, sorting and classifying fruits and vegetables, exploring various seeds, plant bulbs, and sprout seeds, or growing a garden. The goal is to provide children with opportunities to closely observe living things and encourage them to question, explore, and investigate the physical characteristics, behaviors, changes, needs, and habitats of living things.
- Use a variety of resources, such as books with clear and vivid images of plants or audio recordings of animals, to enrich and extend children's study of living things. Resources can serve to inspire new explorations about living things and extend children's firsthand experience of the natural world.

Strand: 4.0 — Earth and Space Science

Sub-Strand — Properties and Characteristics of Earth Materials and Objects

Foundation 4.1 **Characteristics of Earth Materials**

Early
3 to 4 ½ Years

Investigate and describe the characteristics (for example, size, weight, shape, color, texture) of earth materials such as sand, rocks, soil, water, and air.

Later
4 to 5 ½ Years

Investigate and describe the characteristics of earth materials and compare and contrast materials based on their different features (for example, size, weight, shape, color, texture).

Early Examples

■ A teacher puts out a tray with different gems and crystals for children to observe. A child observes the gems and crystals by touching them and looking at them closely and communicates, "I like this one; it's so blue!"

● A child uses a magnifying glass given to them by the teacher to observe sand and communicates in their home language, "I can see many tiny pieces."

Later Examples

■ A teacher puts out a tray with different types of rocks for children to observe. A child observes the surfaces of the rocks and sorts them based on how shiny they are. They communicate, "Here are very shiny rocks. Here are not-so-shiny rocks."

● A child pours water in the sandbox and compares the dry sand with the wet sand. The child communicates in Vietnamese, "The wet sand sticks together," and demonstrates how to make a sand cake by filling up the bucket with wet sand and turning it over.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 4.1 **Characteristics of Earth Materials**

Early
3 to 4½ Years

Early Examples (continued)

A child pours water into a bucket and comments, "It's like soup." Another child says, "Add rocks and make *phở** [noodle soup in Vietnamese]."

While playing outside, a child observes a windmill on a toy set spinning and shares, "I can feel the wind. The air is pushing it."

A child who is visually impaired holds different types of rocks and communicates, "This one feels really smooth, but this one is not very smooth."

* *Phở* is a Vietnamese soup dish that consists of broth, rice noodles, herbs, vegetables, and meat.

Later
4 to 5½ Years

Later Examples (continued)

In an exploration of air introduced and facilitated by the teacher, a child observes a kite flying and describes, "The wind blows really hard, and the kite goes really high into the clouds." When the teacher asks what happens when the wind stops blowing hard, the child responds, "The kite goes down."

A child collects different natural materials in a tray and uses a magnifying glass to observe them closely. The child makes drawings of their observations showing the size, shape, color, and texture of what they collected.

Crosscutting Concepts

Children's investigations and descriptions of earth materials involve noticing stability and change (for example, some substances like sand change form when wet, others do not) and cause and effect (for example, wind moves things like kites).

Sub-Strand — Changes in the Earth and Space

Foundation 4.2 **Natural Objects in the Sky**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Observe and describe natural objects in the sky (sun, moon, stars, and clouds).	Observe and describe natural objects in the sky and describe patterns of movement and apparent changes in the sun, moon, stars, and clouds.

Early Examples

■ A child participates in a class activity observing the sky and describing what the clouds look like. The child comments, "The sky is blue. I see clouds. The clouds look like big cotton balls."

● A child gestures toward the sky and communicates to the teacher, "Last night I looked at the sky. I saw the moon. Sometimes I don't see the moon."

A child with autism records their observation of the sky by drawing a picture. They refer to their drawing and point to the sun and the clouds when the teacher asks, "What did you notice in the sky?"

Later Examples

■ A child participates in a class activity observing the changes in the sky throughout the day. The child shares, "In the morning, the sun was here. Now it moved over there. It is the same as yesterday."

● A child draws a representation of the phases of the moon in their journal using an adapted pencil with support from the teacher. The child describes, "When I looked at the sky with my dad, the moon was round and big. But sometimes it can look like a banana."

A child observes the clouds on a rainy day and, when asked by the teacher, describes how the clouds are different from those on a sunny day. "Sometimes the clouds are white, but today they are gray."

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 4.2 **Natural Objects in the Sky**

Early
3 to 4½ Years

Later
4 to 5½ Years

Early Examples (continued)

A child communicates in Tagalog, "When I look at the sky at night, the stars look like little lights in the sky."

Later Examples (continued)

A child shares, "Last night I saw a full moon. Sometimes we eat mooncakes* when there is a full moon."

*A mooncake is a pastry filled with different types of sweet, dense pastes (for example, lotus seed paste or sweet bean paste) eaten in China and other East Asian and Southeast Asian countries and communities.

Crosscutting Concepts

As children observe and describe the sun, moon, stars, and clouds and how they appear to move and change, they notice and communicate patterns. For example, children recognize the pattern of the sun coming out during the day and the moon and stars coming out at night. Children also become interested in and follow the pattern of the changing phases of the moon. They might talk about stability and change (for example, in the color or shape of clouds or the apparent shape of the moon over time).

Foundation 4.3 **Weather**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Notice and describe changes in weather. Notice the effects of weather and seasonal changes on their own lives and on plants and animals.	Observe and describe changes in weather and provide examples of the effects of changes in weather and seasons on their own lives and on plants and animals.

Early Examples

■ A child looks through the window and comments to the teacher, "It is raining."

● A child participates in a morning activity introduced and facilitated by the teacher to record the weather on a chart. The child picks up the picture card with a drawing of a sun to indicate that it is a sunny day.

On a cold day, a Deaf child gets their jacket from their cubby before going outside and explains using American Sign Language, "I need my jacket. It's cold outside."

After the rain has stopped, a child checks how much water is in the bucket, lifts the bucket, and looks inside.

Later Examples

■ A child observes the weather and notices the gray sky. When the teacher asks, "What do you think the weather will be?" the child predicts by pointing to the weather card representing rain. Then the child expresses, "We need to go inside."

● A child participates in a morning activity introduced and facilitated by the teacher to record the weather on a chart. Observing the chart with the daily recordings of the weather, the child comments, "This week, it was sunny every day. We got to play outside the whole week!"

A child communicates using a mix of English and their home language, "We can't find bugs outside because it's cold and they're hiding under the ground."

A child shares, "Pop-Pop says we can't go outside when it is storming because it's not safe."

■● Matching icons indicate alignment of examples across age-ranges

Crosscutting Concepts

When children describe the weather and seasonal changes, they think about stability and change (for example, noticing that the weather is getting colder). They notice patterns and refer to those patterns to make predictions (for example, when the sky is gray it usually rains, or bugs hide when it is cold). Cause and effect are also likely to come up, for example, when children discuss the effects of wind, rain, or temperatures on objects and people.

Foundation 4.4 **Earth and Human Activity**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Notice, with adult prompting and support, how humans' actions and use of resources impact the environment and their community, participate in activities related to caring for the environment.	Investigate, with adult support, how humans' actions and use of resources impact the environment and their community, discuss in simple terms how to care for the environment, and participate in activities related to its care.

Early Examples

■ When asked by the teacher what they can do with the leftover fruit from lunch, a child suggests that they can give it to the class pet turtle instead of throwing it away.

● A child helps the teacher sort recyclable items such as papers, bottles, and cans by matching like items and putting them in the bin with the corresponding image indicating what goes where.

When playing outdoors, a child reminds a peer that the teacher taught them not to walk on top of the flowers.

Children take turns being the room's "light keeper." When it's their turn, a child turns off the lights when leaving the room to play outside.

Later Examples

■ When asked by the teacher to make drawings of ways to protect the environment, a child makes a drawing of beehives and explains, "Bees are helpers. We should not hurt them."

● A child uses recycling bins with less adult support and reminds another child to put paper scraps in the blue recycling box.

A child shares that they learned that children can help protect Mother Earth too, by conserving water and protecting animals and plants.

A child reminds a peer in Cantonese to turn off the faucet "so we don't waste water."

While playing in the dramatic play area, children pretend that they are standing around a campfire. One child expresses, "We need to turn off the fire. We don't want the forest to burn."

■● Matching icons indicate alignment of examples across age-ranges

Crosscutting Concepts

When children learn and think about the impact of human activity on the environment, they consider cause and effect. This becomes very personal for children as they work to limit their own and others' harmful impacts (for example, remembering to turn off the water to avoid wasting water, or knowing it is important to extinguish a campfire to avoid a forest fire).

History–Social Science — The above foundation is similar to the History–Social Science foundation 5.4 on caring for the world. Both domains intentionally include foundations on children's understanding of the interactions between humans and the environment and how to care for it. In Science, this foundation highlights children's developing understanding of changes in earth and the cause-and-effect relationship between human action and its impacts on the environment.

Supporting Children's Explorations and Learning in Earth and Space Science

Children's learning about earth and space science entails observing and exploring earth objects and events (for example, jumping in puddles or feeling the heat of the sun). The learning also involves identifying patterns of change in the world around them (for example, patterns of day and night, the phases of the moon, changes in weather). Teachers can:

- Provide children with opportunities to explore and experiment with the physical properties of earth materials (such as sand, water, rocks, soil). Having buckets or tables with water or sand during choice time can be an invitation for children to explore the characteristics and changes in these materials.
- Invite children to observe, record, and track changes in the weather and how it affects their lives. Children can comment on their observations of the weather during circle time and keep track of changes on weather charts or by drawing in a science journal.
- Engage children in observing and describing natural objects in the sky (such as clouds and stars). Teachers can invite families to engage in these investigations by helping children document what they observe when they look at the sky.
- Discuss with children the impact that humans have on the natural and built environment. Engage them in activities and routines meant to care for and protect the environment. For instance, teachers can introduce routines around reusing and recycling materials, turning off lights, and conserving water.

Strand: 5.0 — Engineering, Technology, and Applications of Science

Sub-Strand — Engineering Design

Foundation 5.1 **Engineering Design Process**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Engage collaboratively with peers and adults in engineering design by identifying problems in play and everyday activities, planning and creating simple solutions to the problems they identify, and, with adult support, testing and refining their solutions.	Engage collaboratively with peers and adults in engineering design by identifying problems in play and everyday activities, planning and creating more detailed solutions to the problems they identify, and testing and refining their solutions with less adult support and over longer periods of time.

Early Examples

■ After a teacher reads to the group about different types of buildings, a child with spina bifida builds a castle with wooden blocks with the teacher and adds a block with a slanted side, explaining to the teacher, "This is so wheelchairs can go up to the castle."

● After noticing birds in the outdoor space, children communicate to their teacher that they want to feed the birds. The teacher helps children use paper rolls and twine to make simple birdfeeders to hang outside the classroom.

Later Examples

■ After a teacher reads to the group about different types of buildings, a child and a peer create their own city by first planning out their city in a drawing and then using magnetic tiles to build tall and short structures over a series of days.

● After noticing birds in the outdoor space, children communicate to their teacher that they want to build a bird feeder. The children draw how they want the bird feeder to look and, with adult support, build it over multiple weeks with materials brought in by families.

(continued on following page)

■ ● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 5.1 **Engineering Design Process**

Early
3 to 4½ Years

Early Examples (continued)

A child creates a walking path using logs and stepping stones in the outdoor space to get from the sidewalk to the sandbox without stepping on the grass. With the help of the teacher, the child changes the distance from one log or stepping stone to the next so that it is easy to step from one to the other.

After learning about Mae Jemison, the first Black female astronaut to go into space, a child creates a rocket out of cardboard paper rolls and construction paper, making adjustments with the help of a teacher, and pretends to be an astronaut.

Later
4 to 5½ Years

Later Examples (continued)

A teacher shares with children that some of their peers sometimes need quiet time and asks the children to brainstorm what they can do. Children suggest making a cozy corner. "What do we need for a cozy corner?" asks the teacher. The children suggest cushions, scarves, and a light from around the classroom. Over the next week, the children collaborate in making the cozy corner.

Crosscutting Concepts

As children engage in the engineering design process, they are likely to think about structure and function (for example, smooth ramps allow wheelchairs to roll, but stairs do not).

Sub-Strand — Engineering Design and Society

Foundation 5.2 **Design Solutions and Society**

Early 3 to 4 ½ Years	Later 4 to 5 ½ Years
Notice and explore, with adult support, how tools and design solutions help address their own and other people's needs and goals in everyday life.	Explore in more detail how tools and design solutions help address their own and other people's needs and, with adult support, develop different solutions to address the needs of their families and communities.

Early Examples

■ When asked by the teacher, a child describes that bridges help people safely walk from one side of a road to the other side.

● In a class discussion with a farmer, children learn that chicken coops help keep chickens safe from predators.

In a discussion about creating spaces that are welcoming for everyone, a child with a physical disability shares, "I use this special handle to help me hold lots of things. I can hold my spoon, my toothbrush, or my water bottle."

Later Examples

■ After a teacher-facilitated discussion on getting to school safely, a child uses a tablet to make a drawing of their walk to school and adds crosswalks and flashing lights to the drawing to show safe ways to cross the street.

● Children notice that rabbits have been eating the vegetables in their class garden. When the teacher asks them what they might do, the children suggest adding a fence around the garden to keep the rabbits out.

In a discussion about creating spaces that are welcoming for everyone, children learn about braille and do an exploration facilitated by the teacher around the school to find all the different places where braille is used.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 5.2 **Design Solutions and Society**

Early **3 to 4½ Years**	**Later** **4 to 5½ Years**

Early Examples (continued)

While reading a book about the uses of different plants by Native nations and tribal communities in California, the teacher asks, "What did they make with Mojave yucca?"* A child points to the picture of a basket on the page.

A child communicates that their family uses a table that is low to the ground because they sit on cushions on the floor to eat.

*Mojave yucca is a flowering plant native to Southern California.

Later Examples (continued)

With a teacher facilitating, children discuss different types of building structures from around the world and how the materials and design are related to people's needs. One child shares that on their rancheria,** there is a round building, called a roundhouse,*** "where we come together." With the help of their teacher, the group explores how they might use materials to create a round building.

**A rancheria is a Native American base in California.

***A roundhouse is a building used for ceremonial events in some Native nations and tribal communities.

History–Social Science — The above foundation is related to History–Social Science foundation 3.8 on developing solutions and taking action. Both domains intentionally include foundations on children's ability to identify problems, come up with solutions, and take action. In Science, this foundation focuses on the engineering design process and children's use of tools and design solutions to help address their own and other people's needs and goals.

Supporting Children's Exploration of Engineering and Technology

The engineering design process involves (1) identifying and defining engineering problems in everyday life, (2) developing solutions, and (3) testing and refining those solutions. Children explore how engineering and **technology** solutions help address their own and other people's needs. To support children's exploration of engineering and technology, teachers can:

- Provide opportunities for children to identify real-world problems they encounter in play and everyday interactions and support children in coming up with their own solutions. For example, teachers can involve children in building a dark room to explore light and shadow or in creating their own marble runs with a variety of materials.
- Give children ample time to implement, test, and refine their engineering design solutions. Allowing for the engineering design process to take place over multiple days or weeks provides children with opportunities to encounter challenges that they can solve collaboratively. For instance, teachers can support children in creating a representation of their neighborhood using wooden blocks over a series of days.
- Invite children to reflect on how design and technology solutions impact them, the people they know, and society at large (for example, exploring how different technologies help people communicate in different ways).
- Provide books and other media that show children how design solutions are used in everyday life (for example, books about bridges, housing structures from around the world, assistive technologies that support individuals with disabilities).
- Provide opportunities for children to participate in making by setting up making corners or makerspaces with materials, tools (used with adult support and oversight), loose parts, and books or artwork for inspiration for children to work on their own creations, individually and collaboratively.

Foundation 5.3 **Using Digital Devices**

Early **3 to 4 ½ Years**	**Later** **4 to 5 ½ Years**
Demonstrate emerging understanding that different digital tools and devices serve different functions (for example, taking videos or photos) and use digital tools, with adult support, to meet their needs and goals in everyday situations.	Recognize a greater diversity of digital tools and devices and their function (for example, look up information, learn or practice a new skill) and use them with less adult support to meet their needs and goals in everyday situations.

Early Examples

■ While playing outside, a child asks the teacher to take a picture with their phone of a caterpillar the child found to show their parent at pickup.

● In an exploration of sounds, the teacher plays jazz on the music player, and the children listen closely, identifying when the drumbeat is fast and when it is slow. Children ask the teacher to replay parts of the music so they can listen again.

Children use a digital camera, with the help of their teacher, to record a video of their marbles going down a marble run and across the carpet to the finish line. The children watch the video to decide who won. They pause at the moment the marbles cross the finish line to decide whose marble crossed first.

Later Examples

■ A child sees a spider on the playground and asks the teacher for help to search online to figure out what kind of spider it is.

● In an exploration of sounds, the teacher plays jazz on the music player, and the children listen closely to identify different instruments and changes in the music. Children then ask the teacher to show them short video clips of the different instruments they identify (for example, drums, pianos, guitar, horn) and what they sound like when they are played on their own.

Children ask the teacher to show them videos of making a marble maze to learn how to make their own. They choose one video and reference the video while they build the maze.

(continued on following page)

■● Matching icons indicate alignment of examples across age-ranges

(continued)

Foundation 5.3 **Using Digital Devices**

Early
3 to 4½ Years

Early Examples (continued)

After children show interest in the blooming flowers and trees in their neighborhood, the teacher reads a book and then plays a short video about changes that take place in nature during different seasons. With the help of their teacher, the children take photos over the next few weeks documenting the changes they notice during the spring season and create a class picture book.

Later
4 to 5½ Years

Later Examples (continued)

During free-choice time, a child finishes playing a matching card game and asks the teacher if they can try a new matching game on the tablet. The teacher says, "You've played with all the matching cards we have in the classroom, and using a tablet is a good idea to extend your practice with matching! I have a great new game that goes with our unit on animals." The child then goes to the shelf to pick up the tablet and turns it on, and the teacher helps them select the game on matching baby animals and adult animals.

A child notices a bird singing and asks the teacher if they can use the internet to find out what kind of bird it is. When searching for bird songs online, the teacher and the child find that there is an application (app) that helps identify bird songs. They download the app on the class tablet, and the child uses it to record the bird they heard outside and identifies that it is a song sparrow.

Supporting Children's Use of Digital Devices

The use of technology and digital devices can enhance children's science and engineering experiences. Mobile phones, digital cameras, tablets, audio players, and computers provide expanded access to resources and enable teachers and children to obtain a great amount of information to inform their scientific inquiries. These devices also enable children to record observations and track changes over time during scientific investigations and engineering projects. To support children's use of digital devices in science and engineering, teachers can:

- Be intentional in selecting the technology and digital devices for children to use, considering children's developmental level, interests, abilities, and cultural and linguistic backgrounds.
- Plan activities with technology and digital devices that support children to explore, think, experiment, predict, and problem solve rather than be passive consumers of media.
- Allow children to exercise their autonomy in using digital devices, with adult preapproved, safe, and developmentally appropriate content, to explore and problem solve and offer support as needed.
- Provide opportunities for all children to participate in using and have access to technology and digital devices with content oversight to ensure safety. Technology resources can provide access to children's home language and culture. Adaptive and assistive technologies can support children with disabilities in engaging in science and engineering activities.

Glossary

animate/inanimate objects. Animate objects are living things with the capacity to initiate motion or activity. The term refers to animals (including humans) and is distinguished from inanimate objects, such as plants or nonliving objects (for example, a car or a rock).

applications of science. Any use of scientific knowledge for a specific purpose (for example, to design a product, develop new technology, or predict the impacts of human actions).

bodily processes. The basic processes needed for life and growth in humans and other animals (for example, eating, sleeping, breathing, walking).

cause and effect. Cause is what makes something happen (for example, kicking a ball), and effect is what happens as a result of the cause (for example, the ball rolls).

classification. The sorting, grouping, or categorizing of objects according to established criteria.

compare and contrast. Looking at similarities and differences in real objects and events.

crosscutting concepts. Repeated principles and concepts (for example, patterns, cause and effect, stability and change) that carry across science disciplines and help explain scientific phenomena. It is one of the components of the Next Generation Science Standards.

digital devices. Electronic devices such as mobile phones, digital cameras, tablets, and computers that are used to generate, process, share, communicate, and display digital information.

documentation. Preserving evidence by recording information, using different forms, including drawings, photographs, written transcripts, charts, journals, models, and constructions.

earth and space science. The study of earth includes topics related to the properties of earth materials (soils, rocks, and minerals), the ocean, weather, and forces that shape earth. The study of space includes topics related to the characteristics and changes of natural objects in the sky (sun, moon, stars, and clouds).

engineering. A systematic and often iterative approach to designing objects, processes, and systems to meet human needs and wants.

engineering design process. The steps taken to solve engineering problems, which include defining problems, designing solutions, and systematically testing and refining solutions.

experiment. The process of testing a hypothesis by observing how different actions lead to different outcomes to learn about how something in the world works.

habitat. The home, place, or environment where an organism or a biological population normally lives.

heredity. The passing on of traits from parents to their offspring.

hypothesis. A proposed explanation for an observable phenomenon that can be tested by an experiment. A confirmed hypothesis supports a theory. Hypotheses is the plural of this term.

investigation. In the process of scientific inquiry, asking a question and conducting systematic observations or simple experiments to find an answer.

life cycle. The series of changes in the growth and development of humans, animals, and plants.

life science. The study of living things, including plants and animals, and their characteristics, life cycles, habitats, and interrelationships with each other and the environment. The three major branches of life science are biology, physiology, and ecology.

living things/nonliving things. Living organisms have the capacity for self-sustaining biological processes such as growth, breathing, reproduction, and responsiveness to stimuli. Examples of living things are humans, animals, and plants. Nonliving things are inanimate objects or materials that do not undergo biological changes such as birth, growth, and reproduction.

mathematical thinking. Knowledge of early mathematics concepts (for example, number, quantity, geometry/shapes, patterning) when quantifying or describing observations.

measurement tools. Simple tools, such as rulers, measuring cups and spoons, and scales, used to measure length, volume, or weight.

observation. Gathering information about objects and events by using the senses—sight, smell, sound, touch, and taste—and noticing specific details or phenomena that ordinarily might be overlooked.

observation tools. Tools to extend observations such as hand lenses, magnifying glasses, and binoculars.

offspring. The young or immediate descendants of living organisms.

phenomenon. An event or occurrence that can be observed or experienced through the senses. Phenomena is the plural of this term.

physical properties. Observable features of a material, such as how it looks (for example, shape, color), feels (for example, solid, liquid, texture), or behaves (for example, sinks in water).

physical science. The study of nonliving matter and energy. It deals with physical properties and transformations of substances, the nature of motion, force, and energy (for example, mechanical energy, heat, sound, light, electricity). The two major branches of physical science are physics and chemistry.

prediction. An estimation or statement of a future outcome that is based on prior observations, knowledge, and experiences.

record. To set down information or knowledge in writing, drawings, or other permanent forms to preserve evidence or track data over time.

science and engineering practices. Behaviors that children engage in to explore and develop knowledge in science and engineering. It is one of the components of the Next Generation Science Standards.

scientific inquiry. Refers to the diverse ways in which scientists explore and develop knowledge and understanding of scientific ideas: by making observations, posing questions, planning investigations, making predictions, using tools to gather and record information, analyzing data, and communicating findings and explanations.

technology. Any modification of the natural world to fulfill human needs or desires. Technology can refer to simple artifacts, such as paper and pencil, or more complex systems, such as digital devices, satellites, and the internet.

traits. The characteristics or attributes of an organism.

trial and error. The process of repeated, varied attempts to find the solution to a problem or goal.

References and Source Materials

Ashley, Jennifer, and Michael Tomasello. 2001. "Cooperative Problem-Solving and Teaching in Preschoolers." *Social Development* 7 (2): 143–163.

Bagiati, Aikaterini, and Demetra Evangelou. 2015. "Engineering Curriculum in the Preschool Classroom: The Teacher's Experience." *European Early Childhood Education Research Journal* 23 (1): 112–128.

Brenneman, Kimberly, Alissa Lange, and Irena Nayfeld. 2019. "Integrating STEM into Preschool Education: Designing a Professional Development Model in Diverse Settings." *Early Childhood Education Journal* 47: 15–28.

Brenneman, Kimberly, Judi Stevenson-Boyd, and Ellen C. Frede. 2009. "Math and Science in Preschool: Policies and Practice." In *Policy Brief Series* 19, edited by Ellen C. Frede and W. Steven Barnett. New Brunswick, NJ: National Institute for Early Education Research.

Bustamante, Andres S., Daryl B. Greenfield, and Irena Nayfeld. 2018. "Early Childhood Science and Engineering: Engaging Platforms for Fostering Domain-General Learning Skills." *Journal of Research in Education Sciences* 8 (3): 144.

Bustamante, Andres S., Brenna Hassinger-Das, Kathy Hirsh-Pasek, and Roberta M. Golinkoff. 2018. "Learning Landscapes: Where the Science of Learning Meets Architectural Design." *Child Development Perspectives* 13 (1): 34–40.

California Department of Education. 2013a. *California Preschool Curriculum Framework*, Volume 3. Sacramento, CA: California Department of Education.

California Department of Education. 2013b. *Next Generation Science Standards for California Public Schools, Kindergarten Through Grade Twelve*. Sacramento, CA: California Department of Education.

California Department of Education. 2015. "Using Technology and Interactive Media with Preschool-Age Children." In *California Preschool Program Guidelines*, 93–104. Sacramento, CA: California Department of Education.

Callanan, Maureen, Graciela Solis, Claudia Castañeda, and Jennifer Jipson. 2020. "Children's Question-Asking across Cultural Communities." In *The Questioning Child: Insights from Psychology and Education*, edited by Lucas Payne Butler, Samuel Ronfard, and Kathleen H. Corriveau: 73–88. Cambridge, UK: Cambridge University Press.

Carle, Eric. 2009. *The Tiny Seed*. New York, NY: Little Simon.

Clements, Douglas H., and Julie Sarama. 2016. "Math, Science, and Technology in the Early Grades." *The Future of Children* 26 (2): 75–94.

Cook, Claire, Noah D. Goodman, and Laura E. Schulz. 2011. "Where Science Starts: Spontaneous Experiments in Preschoolers' Exploratory Play." *Cognition* 120 (3): 341–349.

Davis, Martha E., Christine M. Cunningham, and Cathy P. Lachapelle. 2017. "They Can't Spell 'Engineering' but They Can Do It: Designing an Engineering Curriculum for the Preschool Classroom." *Zero to Three* 37:4–11.

Dorie, Brianna L., Monica Cardella, and Gina Navoa Svarovsky. 2014. "Capturing the Design Thinking of Young Children Interacting with a Parent." *School of Engineering Education Graduate Student Series*. Paper 52. http://docs.lib.purdue.edu/enegs/52.

Early Childhood STEM Working Group. 2017. *Early STEM Matters: Providing High-Quality STEM Experiences for All Young Learners*. Policy Report. Chicago, IL: University of Chicago.

Ellis, Shari, and Robert S. Siegler. 1994. "Development of Problem Solving." In *Thinking and Problem Solving (Handbook of Perception and Cognition, Volume 2)*, edited by Robert J. Sternberg. New York, NY: Academic Press.

Fleer, Marilyn, Judith Gomes, and Sue March. 2014. "Science Learning Affordances in Preschool Environments." *Australasian Journal of Early Childhood* 39 (1): 38–48.

Fouquet, Nathalie, Olga Megalakaki, and Florence Labrell. 2017. "Children's Understanding of Animal, Plant, and Artifact Properties Between 3 and 6 Years." *Infant and Child Development* 26 (4).

Fragkiadaki, Glykeria, Marilyn Fleer, and Prabhat Rai. 2023. "Science Concept Formation During Infancy, Toddlerhood, and Early Childhood: Developing a Scientific Motive Over Time." *Research in Science Education* 53: 275–294.

French, Lucia. 2004. "Science as the Center of a Coherent, Integrated Early Childhood Curriculum." *Early Childhood Research Quarterly* 19 (1): 138–149.

Fusaro, Maria, and Maureen C. Smith. 2018. "Preschoolers' Inquisitiveness and Science-Relevant Problem Solving." *Early Childhood Research Quarterly* 42:119–127.

Gauvain, Mary, and Robert L. Munroe. 2020. "Children's Questions in Social and Cultural Perspective." In *The Questioning Child: Insights from Psychology and Education*, edited by Lucas Payne Butler, Samuel Ronfard, and Kathleen H. Corriveau. Cambridge, UK: Cambridge University Press.

Gauvain, Mary, Robert L. Munroe, and Heidi Beebe. 2013. "Children's Questions in Cross-Cultural Perspective: A Four-Culture Study." *Journal of Cross-Cultural Psychology* 44 (7): 1148–1165.

Gelman, Rochel, Kimberley Brenneman, Gay Macdonald, and Moisés Román. 2010. *Preschool Pathways to Science: Facilitating Scientific Ways of Thinking, Talking, Doing, and Understanding*. Baltimore, MD: Paul H. Brookes Publishing Company.

Gerde, Hope K., Rachel E. Schachter, and Barbara A. Wasik. 2013. "Using the Scientific Method to Guide Learning: An Integrated Approach to Early Childhood Curriculum." *Early Childhood Education Journal* 41 (5): 315–323.

Gold, Zachary S., James Elicker, Ji Young Choi, Treshawn Anderson, and Sean P. Brophy. 2015. "Preschoolers' Engineering Play Behaviors: Differences in Gender and Play Context." *Children, Youth and Environments* 25 (3): 1–21.

Gopnik, Alison. 2010. "How Babies Think." *Scientific American* 303 (1): 76–81.

Gopnik, Alison. 2012. "Scientific Thinking in Young Children: Theoretical Advances, Empirical Research, and Policy Implications." *Science* 337 (6102): 1623–1627.

Greenfield, Daryl B., Alexandra D. Alexander, and Elizabeth Frechette. 2017. "Unleashing the Power of Science in Early Childhood: A Foundation for High-Quality Interactions and Learning." *Zero to Three* 37 (5): 13–21.

Greenfield, Daryl B., Jamie Jirout, Ximena Dominguez, Ariela Greenberg, Michelle Maier, and Janna Fuccillo. 2009. "Science in the Preschool Classroom: A Programmatic Research Agenda to Improve Science Readiness." *Early Education and Development* 20 (2): 238–264.

Gropen, Jess, Janna Fuccillo Kook, Cindy Hoisington, and Nancy Clark-Chiarelli. 2017. "Foundations of Science Literacy: Efficacy of a Preschool Professional Development Program in Science on Classroom Instruction, Teachers' Pedagogical Content Knowledge, and Children's Observations and Predictions." *Early Education and Development* 28 (5): 607–631.

Gross, Carol M. 2012. "Science Concepts Young Children Learn Through Water Play." *Dimensions of Early Childhood* 40 (2): 3–11.

Gur, Cagla. 2011. "Physics in Preschool." *International Journal of Physical Sciences* 6 (4): 939–943.

Hollingsworth, Heidi L., and Maureen Vandermaas-Peeler. 2017. "'Almost Everything We Do Includes Inquiry': Fostering Inquiry-Based Teaching and Learning with Preschool Teachers." *Early Child Development and Care* 187 (1): 152–167.

Kampeza, Maria. 2006. "Preschool Children's Ideas About the Earth as a Cosmic Body and the Day/Night Cycle." *Journal of Science Education* 7 (2): 119–122.

Keen, Rachel. 2011. "The Development of Problem Solving in Young Children: A Critical Cognitive Skill." *Annual Review of Psychology* 62: 1–21.

Larimore, Rachel A. 2020. "Preschool Science Education: A Vision for the Future." *Early Childhood Education Journal* 48: 703–714.

Larsson, Jonna. 2013. "Children's Encounters with Friction as Understood as a Phenomenon of Emerging Science and as 'Opportunities for Learning.'" *Journal of Research in Childhood Education* 27 (3): 377–392.

Legare, Cristine H. 2012. "Exploring Explanation: Explaining Inconsistent Evidence Informs Exploratory, Hypothesis-Testing Behavior in Young Children." *Child Development* 83 (1): 173–185.

Legare, Cristine H. 2014. "The Contributions of Explanation and Exploration to Children's Scientific Reasoning." *Child Development Perspectives* 8 (2): 101–106.

Legare, Cristine H., Candice M. Mills, André L. Souza, Leigh E. Plummer, and Rebecca Yasskin. 2013. "The Use of Questions as Problem-Solving Strategies During Early Childhood." *Journal of Experimental Child Psychology* 114 (1): 63–76.

Marin, Ananda, and Megan Bang. 2018. "'Look It, This Is How You Know:' Family Forest Walks as a Context for Knowledge-Building About the Natural World." *Cognition and Instruction* 36 (2): 89–118.

McClure, Elisabeth R., Lisa Guernsey, Douglas H. Clements, Susan Nall Bales, Jennifer Nichols, Nat Kendall-Taylor, and Michael H. Levine. 2017. *STEM Starts Early: Grounding Science, Technology, Engineering, and Math Education in Early Childhood*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

Mills, Candice M., Cristine H. Legare, Megan Bills, and Caroline Mejias. 2010. "Preschoolers Use Questions as a Tool to Acquire Knowledge from Different Sources." *Journal of Cognition and Development* 11 (4): 533–560.

National Academies of Sciences, Engineering, and Medicine. 2018. *English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives*. Washington, DC: The National Academies Press.

National Academies of Sciences, Engineering, and Medicine. 2022. *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators*. Washington, DC: The National Academies Press.

National Association for the Education of Young Children and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College. 2012. "Technology and Interactive Media as Tools in Early Childhood Programs Serving Children from Birth Through Age 8." Position Statement. Washington, DC: National Association for the Education of Young Children.

National Research Council. 2012. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press.

Nayfeld, Irena, Kimberly Brenneman, and Rochel Gelman. 2011. "Science in the Classroom: Finding a Balance Between Autonomous Exploration and Teacher-Led Instruction in Preschool Settings." *Early Education and Development* 22 (6): 970–988.

Nayfeld, Irena, Janna Fuccillo Kook, and Daryl B. Greenfield. 2013. "Executive Functions in Early Learning: Extending the Relationship Between Executive Functions and School Readiness to Science." *Learning and Individual Differences* 26:81–88.

Peterson, Shira May, and Lucia French. 2008. "Supporting Young Children's Explanations Through Inquiry Science in Preschool." *Early Childhood Research Quarterly* 23 (3): 395–408.

Piasta, Shayne B., Christina Yeager Pelatti, and Heather Lynnine Miller. 2014. "Mathematics and Science Learning Opportunities in Preschool Classrooms." *Early Education and Development* 25 (4): 445–468.

Piekny, Jeanette, Dietmar Grube, and Claudia Maehler. 2014. "The Development of Experimentation and Evidence Evaluation Skills at Preschool Age. *International Journal of Science Education* 36 (2): 334–354.

Ramanathan, Gurupriya, Deborah Carter, and Julianne A. Wenner. 2022. "A Framework for Scientific Inquiry in Preschool." *Early Childhood Education Journal* 50:1263–1277.

Ronfard, Samuel, Imac M. Zambrana, Tone K. Hermansen, and Deborah Kelemen. 2018. "Question-Asking in Childhood: A Review of the Literature and a Framework for Understanding Its Development." *Developmental Review* 49:101–120.

Schulz, Laura. 2012. "Finding New Facts; Thinking New Thoughts." *Advances in Child Development and Behavior* 43:269–294.

Schulz, Laura. 2012. "The Origins of Inquiry: Inductive Inference and Exploration in Early Childhood." *Trends in Cognitive Sciences* 16 (7): 382–389.

Schulz, Laura E., and Elizabeth B. Bonawitz. 2007. "Serious Fun: Preschoolers Engage in More Exploratory Play When Evidence Is Confounded." *Developmental Psychology* 43 (4): 1045–1050.

Schulz, Laura E., Elizabeth B. Bonawitz, and Thomas L. Griffiths. 2007. "Can Being Scared Cause Tummy Aches? Naive Theories, Ambiguous Evidence, and Preschoolers' Causal Inferences." *Developmental Psychology* 43 (5): 1124–1139.

Schulz, Laura E., and Alison Gopnik. 2004. "Causal Learning Across Domains." *Developmental Psychology* 40 (2): 162–176.

Shillady, Amy, ed. 2013. *Spotlight on Young Children: Exploring Science*. Washington, DC: National Association for the Education of Young Children.

Siry, Christina, and Anna Gorges. 2020. "Young Students' Diverse Resources for Meaning Making in Science: Learning from Multilingual Contexts." *International Journal of Science Education* 42 (14): 2364–2386.

Sisk-Hilton, Stephanie. 2020. "Science, Nature, and Inquiry-Based Learning in Early Childhood." In *Nature Education with Young Children: Integrating Inquiry and Practice*, 2nd ed., edited by Daniel R. Meier. New York, NY: Routledge.

Sobel, David M., and Jessica A. Sommerville. 2010. "The Importance of Discovery in Children's Causal Learning from Interventions." *Frontiers in Psychology* 1:176–183.

Stoll, Julia, Ashley Hamilton, Emilie Oxley, Angela Mitroff Eastman, and Rachael Brent. 2012. "Young Thinkers in Motion: Problem Solving and Physics in Preschool." *Young Children* 67 (2): 20–26.

Tao, Ying. 2016. "Young Chinese Children's Justification of Plants as Living Things." *Early Education and Development* 27 (8): 1159–1174.

Tu, Tsunghui. 2006. "Preschool Science Environment: What Is Available in a Preschool Classroom?" *Early Childhood Education Journal* 33 (4): 245–251.

Ünlütabak, Burcu, Ageliki Nicolopoulou, and Ayhan Aksu-Koç. 2019. "Questions Asked by Turkish Preschoolers from Middle-SES and Low-SES Families." *Cognitive Development* 52:100802.

Villarroel, José D., and Guillermo Infante. 2013. "Early Understanding of the Concept of Living Things: An Examination of Young Children's Drawings of Plant Life." *Journal of Biological Education* 48 (3): 119–126.

Warneken, Felix, Jasmin Steinwender, Katharina Hamann, and Michael Tomasello. 2014. "Young Children's Planning in a Collaborative Problem-Solving Task." *Cognitive Development* 31:48–58.

Waters, Victoria, and Chih-Ing Lim. 2021. "A Guide to Asking Open-Ended Questions." The STEM Innovation for Inclusion in Early Education (STEMI^{2}E^2) Center.

Waters, Victoria, Tracey West, Chih-Ing Lim, Pip Campbell, and Sarah Pedonti. 2022. "A Guide to Teaching Practices." The STEM Innovation for Inclusion in Early Education (STEMI^{2}E^2) Center.

Waters, Victoria, Tracey West, Chih-Ing Lim, and Megan Vinh. 2022. "A Guide to Adaptations." The STEM Innovation for Inclusion in Early Education (STEMI^{2}E^2) Center.

Zimmerman, Corinne, and David Klahr. 2018. "Development of Scientific Thinking." In *Stevens' Handbook of Experimental Psychology and Cognitive Neuroscience, Volume 4*, edited by Simona Ghetti and John T. Wixted. New York, NY: John Wiley and Sons, Inc.