# Preschool Through Third Grade (P–3) Learning Progressions

Science

California Department of Education

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# Introduction

The *Preschool Through Third Grade (P–3) Learning Progressions in Science* shows the correspondence between the *Preschool/Transitional Kindergarten Learning Foundations (PTKLF) in Science*[1] and the *Next Generation Science Standards for California Public Schools, Kindergarten Through Grade Twelve (CA NGSS)*[2] in five key areas of development. This resource includes the knowledge and skills children develop over the P–3 continuum and in-practice examples that illustrate how educators can use playful, inquiry-based teaching practices to engage children in developmentally appropriate, culturally sustaining science and engineering learning experiences.

## How does children's early development in science inform P–3 teaching and learning?

Young children develop science and engineering knowledge and skills that provide the foundation for learning in later grades. Children gain science and engineering knowledge and practices from their families, communities, and other spaces in which they live and learn even before entering formal learning spaces.[3] Through playful, experiential learning, children draw connections between their experiences and how the world works. They make observations and predictions, conduct investigations, and communicate information or design solutions with others. They notice patterns, investigate cause-and-effect relationships, and observe stability and change in the natural and built world.[4] Understanding child development promotes high-quality P–3 science and engineering teaching. We know the following from developmental and learning sciences research:

- Children are curious and learn about the world through exploration and investigation.
- Children make sense of new information based on previous knowledge and experiences.
- Children can engage in meaningful learning of core concepts in physical, life, earth and space science, and engineering and technology.
- Children's explorations of science and engineering concepts and practices in their everyday lives vary based on their experiences as individuals within their families and communities. Culturally sustaining approaches to practice provide children with relevant opportunities to experiment with science and engineering and develop deeper understandings.[5]

Educators can create the conditions to engage children in authentic science inquiry through hands-on, playful learning experiences. Authentic science explorations make connections to and draw from children's lived experiences and cultural, family, and community knowledge as relevant sources of science learning to prepare children to be justice-oriented decision-makers in issues that matter to them and their communities. Educators also engage children in meaningful science and engineering learning experiences inspired by children's own observations and curiosity. When educators draw from and build on children's interests and probing questions, they can generate excitement around science and engineering. Problem-based science and engineering learning experiences allow children to explore real-world problems. As children engage in scientific inquiries and engineering design problems, educators can invite children to reflect on what they are learning and share it with each other and the wider community.

Considering ethical decision-making with children during inquiry- and problem-based learning activities in preschool through third grade helps them to become informed, responsible adults.[6] Refer to the P–3 Science Teaching Practices in this document for ways in which educators can plan and facilitate science and engineering learning experiences that are engaging for all learners and foster a sense of belonging.

## P–3 Science Teaching Practices

- **Enhance children's sense of belonging in science by connecting learning experiences to children's everyday life, home, and cultural experiences.** Children come to school with existing ideas about how the world works based on their experiences at home and in their communities. By building relationships with families and learning about the questions related to science and engineering that arise in the home environment and the knowledge families and communities have about science and engineering, educators can plan learning experiences that build on children's existing home and cultural knowledge and help them find relevant connections between their science learning and what they already know.[7]
- **Identify children's emerging science and engineering practices and understanding and build on their interests and insights.** Observe children and pay attention to their ideas to identify everyday moments when science and engineering concepts can be extended or children can be prompted to make new discoveries. Educators can follow children's lead and support them in planning their own science and engineering investigations that draw on their interests and discoveries. Educators can use their observations of children's questions and interests to plan learning activities.[8] Noticing children's science and engineering skills and knowledge also helps educators provide appropriate supports and scaffolding while encouraging children to grapple with questions or setbacks that arise as they explore and participate in learning activities.
- **Set up an environment that invites curiosity and promotes inquiry-based, playful science and engineering learning.** Educators can intentionally set up materials and learning environments that promote rich engagement and hands-on experiences that children can engage in over time. One of the best ways to engage children in science learning is through playful explorations and investigations that follow their own questions and real problems they encounter in everyday play and interactions. Educators can use indoor and outdoor spaces to generate interest and curiosity in science and engineering learning experiences. Outdoor investigations can promote field-based science skills in a learning environment that is authentic to the real world. Educators can also extend learning experiences outside the classroom and the school by planning investigations in school gardens and libraries, during neighborhood and nature walks, or when visiting museums and aquariums.[9]

- **Create opportunities for children to engage in meaningful science investigations that help children explain phenomena and solve engineering problems that address pressing issues in their lives and communities.** Phenomena are events in the natural and constructed world. Children learn by directly experiencing these phenomena and are more likely to understand and use ideas when they have had concrete and relevant experiences to draw upon. Educators should provide opportunities for children to make discoveries through authentic exposure to rich real-world learning experiences in science and engineering. Furthermore, science is a social endeavor, and educators can support learning by planning opportunities for children to engage in science investigations and engineering projects with peers, similar to how professional scientists and engineers do their work collaboratively.[10]
- **Support children's science discourse and multiple forms of representing science and engineering understanding.** Experiential learning in science is a key opportunity for children to learn new vocabulary with the purpose of communicating their wonderings, explorations, observations, and insights. Educators can ask probing questions that build upon children's questions in ways that invite them to engage in scientific discourse. These probing questions can provide scaffolding for children to use science language and vocabulary for the purpose of meaning-making. Furthermore, asking children to consider the ethical aspects of the science or engineering problems they are addressing can help them build complex social and reasoning skills. Educators should offer children a variety of ways to communicate and represent their science understanding, including drawings, models, diagrams, movement, and role-play.[11]

# How are the P–3 Learning Progressions in Science organized?

## Key Areas

The P–3 Learning Progressions in Science delineate the development of children's science and engineering knowledge and skills from preschool through third grade in five key areas:

- **Key Area 1: Science and Engineering Practices**
  Practices to explore and develop science and engineering knowledge and skills. Learning progressions include asking questions and defining problems, planning and carrying out investigations, developing and using models, mathematical thinking and interpreting data, and formulating and communicating explanations and solutions.
- **Key Area 2: Life Science**
  Understanding of the properties, characteristics, interactions, and changes of living things. Learning progressions include structures and processes of living things; growth, development, and needs of living things; heredity and traits of living things; and habitats and biodiversity.
- **Key Area 3: Physical Science**
  Understanding of the properties, characteristics, interactions, and changes of nonliving matter. Learning progressions include characteristics of objects and materials, changes in objects and materials, force and motion, light and sound waves, and energy.
- **Key Area 4: Earth and Space Science**
  Understanding of Earth's place in the universe, Earth's systems, and the interaction of humans and Earth. Learning progressions include characteristics of Earth's materials and systems, Earth's place in the universe, weather and climate, and Earth and human activity.
- **Key Area 5: Engineering, Technology, and Applications of Science**
  Skills and understanding of engineering design and the use of science and technology in society. This includes the learning progression of engineering design.

## Learning Progressions Tables

Each key area includes learning progressions tables that present children's development of skills and concepts from preschool through third grade drawn from the *PTKLF* in Science, the *CA NGSS*, and the *Science Framework for California Public Schools: Kindergarten Through Grade Twelve* (Science Framework).[12] The learning progressions have been written, organized, and labeled in ways that highlight the continuity between the *PTKLF* and the *CA NGSS* and summarize key learning expectations across the resources. Although the *CA NGSS* organize standards by K–Grade 2 and Grades 3–5 grade bands, the content included in the learning progressions tables focuses on preschool, TK, and kindergarten through third grade (K–3) to align with the P–3 focus of this resource.

## In-Practice Examples

After the learning progressions tables in each key area, there are in-practice examples that illustrate playful, inquiry-based, and culturally sustaining practices that educators can use to support children of diverse abilities and backgrounds in science and engineering learning across different grades. In-practice examples across key areas include references to the science and engineering practices children use and crosscutting concepts that children draw on to make meaning of science and engineering experiences. A section, Highlights from the in-practice examples, at the end of the in-practice examples in each key area offers a description of how educators in the examples used teaching practices to support learning and embrace the diversity of learners in their classrooms.

Additionally, at the end of the document there are appendices that provide further information to support teaching. Appendix A offers guidance on strategies educators can use to support English language development (ELD) for multilingual learners. Appendix B includes references to vignettes in other resources to help further illustrate the teaching practices included in the in-practice examples.

# P–3 Learning Progressions in Science

## Key Area 1: Science and Engineering Practices

From preschool through third grade, children develop practices essential to investigating and learning about science and engineering knowledge and skills. Beginning in preschool and transitional kindergarten (TK), they demonstrate their curiosity about science and engineering phenomena by asking questions and identifying problems in their everyday play and interactions. They make observations and carry out simple investigations and solutions. In the early elementary years, children's investigation and engineering skills become more complex. Their questions and proposed solutions to problems are informed by prior experiences and a more detailed understanding of phenomena. They learn to use evidence to construct or support their explanations or engineering designs, and their investigations and data interpretation become more precise.

## Learning Progression 1.1: Asking Questions and Defining Problems

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards* | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3**** |
| PTK.Early.1.3. Demonstrate curiosity and raise simple questions about objects and events in their environment.<br><br>PTK.Early.1.4. Identify problems during play and everyday interactions and try simple solutions on their own or in collaboration with peers and adults. | PTK.Later.1.3. Demonstrate curiosity and an increased ability to formulate more detailed and specific questions about objects and events in their environment.<br><br>PTK.Later.1.4. Identify problems during play and everyday interactions and try multistep solutions on their own or in collaboration with peers and adults. | **Science and Engineering Practice 1**<br>▪ Ask questions based on observations to find more information about the natural and/or designed worlds.<br>▪ Ask and/or identify questions that can be answered by an investigation. | **Science and Engineering Practice 1**<br>▪ Ask questions about what would happen if a variable were changed.<br>▪ Identify scientific (testable) and non- scientific (non-testable) questions.<br>▪ Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause-and-effect relationships.<br>▪ Use prior knowledge to describe problems that can be solved. |

* CA *NGSS* progression statements in this table are adapted from appendix 1 of the *Science Framework*.

** Tables refer only to Grade 3 in the column heading, but the statements cover Science and Engineering Practices for Grades 3–5 as described in the *CA NGSS*.

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## Learning Progression 1.1: Asking Questions and Defining Problems

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| | | ▪ Define a simple problem that can be solved through the development of a new or improved object or tool.<br>(K-ESS3, K-2 ETS1) | ▪ Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.<br>(3-PS2, 3-5 ETS1) |

## Learning Progression 1.2: Planning and Carrying Out Investigations

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.1.1. Observe and actively explore objects and events using their senses and describe their observations.<br><br>PTK.Early.1.2. Compare and contrast objects and events and describe similarities and differences based on observable properties.<br><br>PTK.Early.1.5. Make simple predictions, begin to give reasons for their predictions, and, with adult support, check the predictions through concrete experiences. | PTK.Later.1.1. Observe and actively explore objects and events using their senses; describe and provide explanations for their observations.<br><br>PTK.Later.1.2. Compare and contrast objects and events based on physical properties and function and describe similarities and differences in greater detail.<br><br>PTK.Later.1.5. Make more detailed predictions drawing on prior experiences and observations, create plans to check predictions with adult support, and begin to discuss why predictions were correct or incorrect. | **Science and Engineering Practice 3**<br>▪ With guidance, plan and conduct an investigation in collaboration with peers (for K).<br>▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.<br>▪ Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.<br>▪ Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. | **Science and Engineering Practice 3**<br>▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.<br>▪ Evaluate appropriate methods and/or tools for collecting data.<br>▪ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. |

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## Learning Progression 1.2: Planning and Carrying Out Investigations

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.1.6. Carry out simple experiments and investigations, on their own or in collaboration with peers and adults, to test their ideas and explanations about their observations.<br><br>PTK.Early.1.7. Identify and use some observation and measurement tools, with adult support. | PTK.Later.1.6. Carry out more complex experiments and 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 new hypotheses.<br><br>PTK.Later.1.7. Identify and use a greater variety of observation and measurement tools. Spontaneously use an appropriate tool, though may still need adult support. | **Science and Engineering Practice 3**<br>▪ Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.<br>▪ Make predictions based on prior experiences.<br><br>(K-PS3, 1-PS4, 1-ESS1, 2-PS1, 2-LS2, 2-LS4) | **Science and Engineering Practice 3**<br>▪ Make predictions about what would happen if a variable changes.<br>▪ Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.<br><br>(3-PS2, 3–5-ETS1) |

## Learning Progression 1.3: Developing and Using Models

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.1.8. Record observations or findings and use simple representations, including drawings, models, movement, role-play, and other methods, to convey their observations and understanding of science concepts, with adult support. | PTK.Later.1.8. Record observations or findings more regularly and in greater detail and use more detailed representations, including drawings, models, charts, diagrams, movement, role-play, and other methods, to convey their observations and understanding of science concepts, with adult support. | **Science and Engineering Practice 2**<br>▪ Distinguish between a model and the actual object, process, and/or events the model represents.<br>▪ Compare models to identify common features and differences.<br>▪ Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).<br>▪ Develop a simple model based on evidence to represent a proposed object or tool.<br>(K-ESS3, K–2-ETS1, 2-LS2) | **Science and Engineering Practice 2**<br>▪ Identify limitations of models.<br>▪ Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regularly occurring events.<br>▪ Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.<br>▪ Develop and/or use models to describe and/or predict phenomena.<br>▪ Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.<br>▪ Use a model to test cause-and-effect relationships or interactions concerning the functioning of a natural or designed system.<br>(3-LS1) |

## Learning Progression 1.4: Mathematical Thinking and Interpreting Data

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.1.9. Use mathematical thinking to analyze and quantify their observations and answer questions that arise in everyday activities, with adult support. | PTK.Later.1.9. Use mathematical thinking more independently and with greater precision to analyze and quantify their observations and answer questions that arise in everyday activities, with adult support. | **Science and Engineering Practice 4**<br>▪ Record information (observations, thoughts, and ideas).<br>▪ Use and share pictures, drawings, and/or writings of observations.<br>▪ Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.<br>▪ Compare predictions (based on prior experiences) to what occurred (observable events).<br>▪ Analyze data from tests of an object or tool to determine if it works as intended.<br>(K-LS1, K-PS2, K-ESS2, 1-ESS1, 2-PS1, K–2-ETS1) | **Science and Engineering Practice 4**<br>▪ Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.<br>▪ Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.<br>▪ Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.<br>▪ Analyze data to refine a problem statement or the design of a proposed object, tool, or process.<br>▪ Use data to evaluate and refine design solutions.<br>(3-LS3, 3-LS4, 3-ESS2) |

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## Learning Progression 1.4: Mathematical Thinking and Interpreting Data

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| | | **Science and Engineering Practice 5**<br>▪ Decide when to use qualitative versus quantitative data.<br>▪ Use counting and numbers to identify and describe patterns in the natural and designed world(s).<br>▪ Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.<br>Use quantitative data to compare two alternative solutions to a problem. | **Science and Engineering Practice 5**<br>▪ Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.<br>▪ Organize simple data sets to reveal patterns that suggest relationships.<br>▪ Describe, measure, estimate, and/or graph quantities (for example, area, volume, weight, time) to address science and engineering questions and problems.<br>Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem. |

## Learning Progression 1.5: Formulating and Communicating Explanations and Solutions

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.1.10. Formulate and communicate simple explanations and solutions, in collaboration with peers and adults, based on information gathered through observations and playful explorations. | PTK.Later.1.10. Formulate and communicate more detailed and precise explanations and solutions, in collaboration with peers and adults, based on information gathered through observations and playful explorations. | **Science and Engineering Practice 6**<br>▪ Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.<br>▪ Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.<br>▪ Generate and/or compare multiple solutions to a problem.<br>(K-PS3, 1-LS1, 1-LS3, 1-PS4, 2-ESS1, 2-ESS2, 2-PS1) | **Science and Engineering Practice 6**<br>▪ Construct an explanation of observed relationships (for example, the distribution of plants in the backyard).<br>▪ Use evidence (for example, measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.<br>▪ Identify the evidence that supports particular points in an explanation.<br>▪ Apply scientific ideas to solve design problems.<br>▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.<br>(3-LS3, 3-LS4, 3–5-ETS1) |

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## Learning Progression 1.5: Formulating and Communicating Explanations and Solutions

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| | | **Science and Engineering Practice 8**<br>▪ Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.<br>(K-ESS3, 1-LS1)<br>*Refer to Science and Engineering Practice 7 and 8 in appendix 1 of the Science Framework for additional skills related to formulating and communicating explanations and solutions.* | **Science and Engineering Practice 8**<br>▪ Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.<br>(3-ESS2)<br>*Refer to Science and Engineering Practice 7 and 8 in appendix 1 of the Science Framework for additional skills related to formulating and communicating explanations and solutions.* |

# In-Practice Examples

## Learning Progression 1.2: Planning and Carrying Out Investigations

### Investigating Earth and Space Science Phenomena

The in-practice examples below illustrate how educators support children to use science and engineering practices to carry out investigations focused on earth and space science phenomena in preschool and first grade (refer to the learning progression Planning and Carrying Out Investigations). In preschool, children investigate the length of their shadows at different times of the day, and in first grade they investigate the amount of daylight at different times of the year. In the examples, children plan and carry out investigations. They analyze and interpret data, use mathematical thinking, and develop models. They also identify patterns, a crosscutting concept. While the in-practice examples below are grade specific, educators in other grades can adapt similar strategies to support children in carrying out investigations.

### As you read,

Notice how children of different ages and in different grades:

- Plan and conduct an investigation and collect data to serve as the basis for evidence to answer a question about increasingly complex science phenomena.
- Make increasingly detailed observations and measurements to collect data that can be used to make comparisons.
- Draw from their ever-growing prior knowledge to make predictions about the phenomena they investigate.

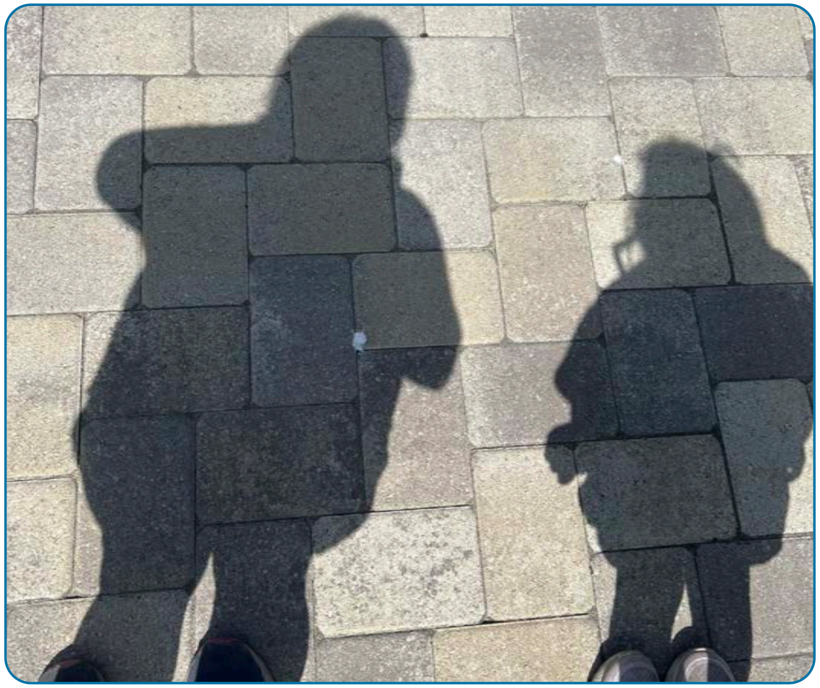
Notice how educators:

- Create opportunities for children to engage in meaningful science investigations that focus on real phenomena related to the sun.
- Support children's science discourse by engaging them in discussions about their observations and encourage them to use multiple forms of representations to share what they find, including creating opportunities for multilingual learners to contribute and make connections using their home languages.
- Enhance children's sense of belonging in science by inviting families to be part of science learning in the classroom and using culturally responsive practices.
- Support children with disabilities to engage actively in science investigations and contribute to collaborative learning with peers.

## Investigating Shadows Throughout the Day (Later Preschool/TK)*

Children in Teacher Maria's preschool class have shown a lot of interest in their shadows during outdoor play, and she decides to build on this curiosity and carry out an investigation to continue exploring. She begins by asking children questions about what they already know about shadows. Children share that they have noticed that their shadows follow them everywhere and sometimes they are big and sometimes they are small. During the morning meeting the next day, Teacher Maria reads books about shadows. She reads books such as *What Makes a Shadow?* and *I See a Shadow*. Teacher Maria has also asked families to record the word "shadow" in their home languages (Spanish, Vietnamese, and Arabic) and plays the words for the children to repeat the words. As she reads the books, Teacher Maria fosters conversation to learn about what children know about shadows and inform the questions they would like to investigate. Based on children's questions, Teacher Maria shares, "You have noticed that sometimes shadows are small and sometimes they are big. We can go outside and investigate how the shadows of different things change throughout the day." With Teacher Maria's guidance, the class plans to go outside and choose objects they would like to measure in the morning and in the afternoon to learn how they might change throughout the day.

Once outside, Teacher Maria asks the children to help her choose objects that make shadows and, with her help, mark the length of the shadows using chalk. The group chooses a tree, a tricycle, a play structure, a water fountain, and a bird feeder. Glory asks if they can also trace her shadow. Dante comments, "Glory, I can see your walker in your shadow." Teacher Maria takes photos of the objects and their traced shadows. When the class comes back inside and sits on the carpet, Teacher Maria displays the photos on the wall and goes around the circle giving each child an opportunity to share what they noticed about the shadows.



* This preschool in-practice example can also apply to TK programs serving four- and five-year-old children.

She offers a language frame that children can use if they need it: "I noticed ____." One child describes, "I noticed that the tree shadow was long, like a monster." Glory shares, "I noticed I looked sooo tall. My walker, too." When it is Sam's turn to share, he chooses to pass. Teacher Maria then asks Sam if he wants to point to something he noticed in the pictures. Sam points to a shadow noting "big!" and Teacher Maria models saying, "I noticed the shadow was big" while Sam imitates.

In the early afternoon, the children go back outside to look at the same objects they observed in the morning and help Teacher Maria mark the length of each shadow. The markings from the morning are still there, and the children notice that the shadows are now shorter. "Wow, my shadow is small!" exclaims Glory. Another child notices that they can't see the shadows of some objects at all anymore. Teacher Maria takes photos of the new shadows.

When the children return to the classroom, Teacher Maria displays the photo of each object from the morning next to the photo of the object in the afternoon. She asks the children once again to share, going around the circle using the language frame from the morning. One child says, "I noticed the tree shadow was short now. Didn't look like a monster anymore." "And Glory's shadow wasn't so tall," adds another child. Sam points to the afternoon photo of one of the objects and shares, "I noticed that shadow was gone!" Teacher Maria replies, "I saw that, too!" Teacher Maria describes that they will go out again the next day and repeat the investigation. "I wonder what the shadows will look like tomorrow," she says. "I think they are going to be tall, then short," predicts Glory. Over the next few days, the class goes outside to observe and document the shadows each day. Teacher Maria intentionally uses the words "observe," "notice," "document," "measure," and "shadows" and supports the children to use the words as they discuss their observations. At the end of the investigation, the class creates an "I See a Shadow" book that

**Engaging multilingual learners in science and engineering learning experiences.** Science and engineering experiences provide concrete and language-rich opportunities for multilingual learners to develop their communication skills and expand their vocabulary in both their home languages and English. Through hands-on, inquiry-based science and engineering learning experiences, multilingual learners can make connections between real-world phenomena and the vocabulary and concepts they know in their home languages and the new vocabulary being introduced. Through collaborative learning with peers, children can also practice their vocabulary and provide support to one another in communicating their ideas. In addition to using their home languages, English, or a combination of English and their home languages, children may also demonstrate their understanding through drawing, building, and modeling with different materials and through movement and play.

includes the photos of shadows and drawings children have made with descriptions of their observations that the children dictated to Teacher Maria and family volunteers. The children "read" the book to each other in small groups and then take turns taking it home to enjoy with their families.

## Investigating Daylight During Different Times of the Year (First Grade)

Ms. Morrison's first-grade class has been making observations of the sun, moon, and stars to describe their patterns. To help extend their learning, Ms. Morrison presents a long-term investigation of daylight during different times of the year, which will combine children's science inquiry skills and mathematical reasoning. With Ms. Morrison's support, the children generate a question they are interested in investigating: How does daylight change throughout the year? They also brainstorm ways to explore this question. Damian suggests, "We can ask our parents how long each day is." Mithun suggests, "Can we find out using the computer?" And Camila adds, "Yes, we can ask the computer when the sun is in the sky and when it's not." Ms. Morrison responds, "These are all interesting ideas. There are many ways to find out when the sun rises and when it sets. We can use that information to figure out how much daylight each day has." She shows the children a website where they will be checking the sunrise and sunset times. "We'll be collecting data on what time the sun rises and sets on every Monday of each week throughout the year."

On Mondays when the class checks the sunrise and sunset times, Ms. Morrison helps the children calculate how many hours of daylight each day has and use a bar graph or block towers to represent the hours of daylight. To help make connections to their own experiences, Ms. Morrison asks the children, "When you went to sleep last night was it light or dark?" "How about when you woke up this morning?" One day in November, Mithun uses a language frame Ms. Morrison provides and shares, "I notice that the time is going down. When we started it was 12 and now it's 10 hours." Ms. Morrison responds, "You have noticed a pattern. What do you think will happen next month?" "I'm not sure," answers Mithun. "We can keep recording the hours of daylight and let's see what we notice," says Ms. Morrison. "For now, let's share predictions about what we think might happen next month." Ms. Morrison writes a language frame on the board that children can use to share, "I predict that next month ____." She invites children to share their predictions with their table groups. As Ms. Morrison listens in, she notices that some children think the hours of daylight will keep decreasing and others think they will increase. She then asks the children to share what they discussed with the larger group and writes the predictions on large chart paper that they refer to over the following months.

In January, the children examine the bar graph and notice that the bars on the graph have been going down. After sharing their observations in pairs, Mithun says, “Now I notice the hours of daylight are going down.” Camila responds, “Yes, but then today’s number is bigger than last week.” “I predict it’s going to start going up now,” says Mithun. In March, the children learn about traditions from around the world that celebrate spring. Based on the discussions she’s had with families about their cultural backgrounds, Ms. Morrison pays special attention to Nowruz from Iran, Holi from India, and the spring equinox celebrated in Teotihuacan near Mexico City. The children have a lively discussion about why these celebrations take place when daylight increases. When they look at their daylight graph from fall to spring, they notice that the bars have been going up for a while and predict that daylight will continue to increase until the fall. At the end of the year, the children present the bar graph they have created as a class to their families and describe what they learned. Mithun tells his family, “We noticed that the sun sets and rises at different times in the year.” Camila continues, “We also learned that the hours of daylight go down in the fall and winter and go up in the spring and summer.” Other children share the stories and celebrations from around the world they learned about.

## Highlights from the in-practice examples

**The educators engage children in planning and carrying out a meaningful investigation.** The children investigate a real phenomenon related to earth and space science that they can observe firsthand and that affects their daily lives. They make observations, gather data, analyze and interpret data, use mathematical thinking, and develop models. These science learning experiences build on children's prior knowledge and skills and serve as the basis for a more complex understanding of earth and space science phenomena in later grades. In addition, by engaging in investigations with peers, children build on each other's insights and skills.

Here are other ways to engage children in meaningful science investigations:

- Support children in investigating phenomena they can experience firsthand in their daily experiences using science and engineering practices. For example, if children show interest in ladybugs outdoors (life science) or notice the changing sound of an ambulance as it gets closer and then farther away (physical science), use these as opportunities to engage children in designing their own investigations.
- Refer to what children experience in their local community to inspire new investigations. For example, if children live near the ocean or desert, ask children to start with what they have experienced and know about those environments before exploring related science phenomena.

**The educators engage children in discussions about their observations** by asking questions such as, "What happened to the shadows this time around?" and "What do you think will happen next month?" The educators also encourage children to use **multiple forms of representations** to share their observations and predictions. Children in Teacher Maria's class refer to photos and make drawings of their observations of the changing shadows throughout the day. They even create a book to share with their families. Teacher Maria also incorporates **multilingual learners'** home languages to enhance their participation in science investigations. She works with families to learn and share vocabulary related to their investigation of the languages represented in the classroom. Children in Ms. Morrison's class write down their predictions and create a graph of daylight hours.

**The educators enhance children's sense of belonging in science** by inviting them to share what they learned with their families. This not only recognizes knowledge and skills in science but it also makes children's families part of the learning process. In addition, Ms. Morrison uses

**culturally sustaining practices** that connect children's learning in science to knowledge and traditions in different cultures, some of which reflect the cultures of children in the classroom.

**The educators support all children to actively engage and contribute to collaborative learning with peers.** The educators support the inclusion of all children, including those with disabilities and a range of learning needs, by adhering to Universal Design for Learning (UDL) principles and providing adaptations when needed. For example, Teacher Maria invites children to choose the shadows they want to measure, and Glory, a child who uses a walker, suggests measuring her shadow. Teacher Maria also supports Sam's engagement in the group discussion by allowing him to choose how he wants to express his knowledge and then modeling the language he uses to share his insights with the class. Ms. Morrison ensures that the visual information in the bar graph is also represented in a tactile way by creating block towers of hours in the day.

**The educators support multilingual learners' engagement in science and engineering experiences and simultaneous English language development.**

- Both educators support the children to express complex ideas and develop vocabulary by providing open-ended language frames with academic vocabulary and complex grammatical structures, such as "I notice that ____" (LLD:ELD.1.1., LLD:ELD.1.4.; ELD.PI.1.12., ELD.PII.1.7.).
- Both educators support equitable and productive talk by providing each child an opportunity to share their ideas with partners or small groups before a large group discussion (LLD:ELD.1.10.; ELD.PI.1.1.).

**Designated ELD (K–3 educators):** In addition to integrated ELD (described above), during designated ELD time, Ms. Morrison works with English learners to use precise vocabulary (ELD.PI.1.12b.) as they explain their reflections about their science observations (ELD.PI.2.9.). Throughout the week, Ms. Morrison engages the children in dramatic play using the new language and teaches them songs with the precise words, which gives the children an opportunity to use the words many times, in multiple and meaningful ways.

# Key Area 2: Life Science

From preschool through third grade, children grow in their understanding of animals and plants, including their body parts, behaviors, and how they grow, meet their needs, and reproduce. Starting in preschool and TK, children can observe and describe the characteristics and needs of animals and plants. In the early elementary years, they can describe the unique life cycles of different organisms and explain how different characteristics of living things help them survive. Their understanding of how organisms inherit traits and how habitats meet the needs of living things becomes more complex.

## Learning Progression 2.1: Structures and Processes of Living Things

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards* | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.3.1. Identify and describe characteristics of a variety of animals and plants, including appearance (inside and outside) and behavior, and begin to categorize them.<br><br>PTK.Early.3.2. Begin to indicate knowledge of bodily processes (for example, eating, sleeping, breathing, walking) in humans and other animals.<br><br>PTK.Early.3.3. 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. | PTK.Later.3.1. Identify and describe characteristics of a greater variety of animals and plants and demonstrate an increased ability to categorize them.<br><br>PTK.Later.3.2. Indicate greater knowledge of bodily processes (for example, eating, sleeping, breathing, walking) in humans and other animals.<br><br>PTK.Later.3.3. Indicate knowledge of the difference between living and nonliving things and recognize that only living things (people, animals, plants) undergo biological processes such as growth, illness, healing, and dying. | *In kindergarten through second grade, children build their understanding that all organisms have external parts that help them survive and grow.*<br><br>1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. | *In third through fifth grade, children build their understanding that plants and animals have both internal and external parts that serve various functions related to their survival, behavior, and reproduction.*<br><br>*No standards in third grade focus on these life science disciplinary core ideas. Related standards are found in fourth grade.* |

* *CA NGSS* progression statements in this table are adapted from the Performance Expectations in the *CA NGSS*, also summarized in appendix 1 in the *Science Framework*.

## Learning Progression 2.2: Growth, Development, and Needs of Living Things

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.3.6. Observe and explore growth and changes in humans, animals, and plants and communicate understanding that living things change over time in size and in other capacities as they grow and age.<br><br>PTK.Early.3.7. Recognize that animals and plants require care and begin to associate feeding and watering with the growth and survival of humans, animals, and plants. | PTK.Later.3.6. 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).<br><br>PTK.Later.3.7. Describe the needs of humans, animals, and plants for growth and survival (for example, food, water, sleep, sunshine, shelter). | *In kindergarten through second grade, children continue to build their understanding of the needs of animals and plants to grow and survive along with the behaviors and characteristics that help them meet their needs and survive.*<br><br>K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.<br><br>1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.<br><br>1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. | *In third through fifth grade, children build a detailed understanding of the needs of animals and plants to grow and survive along with the processes by which they do so, including reproduction and life cycles.*<br><br>3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.<br><br>3-LS2-1. Construct an argument that some animals form groups that help members survive. |

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## Learning Progression 2.2: Growth, Development, and Needs of Living Things

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| 3 to 4 ½ Years Old | 4 to 5 ½ Years Old | Kindergarten Through Grade 2 | Grade 3 |
| | | 2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.<br>2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. | 3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. |

## Learning Progression 2.3: Heredity and Traits of Living Things

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.3.4. Name and describe similarities and differences they observe between grown animals, including humans, and their offspring. | PTK.Later.3.4. Express their expectation that offspring will reflect similar characteristics to grown animals and plants of the same kind. | *In kindergarten through second grade, children expand their understanding that young animals and plants are very much, but not exactly, like their parents and that individuals of the same kind are similar but can also vary in many ways.*<br><br>1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. | *In third through fifth grade, children build their understanding that many characteristics of living things are inherited from their parents and others result from interactions with the environment. They also learn that different organisms vary in how they look and function because they have different inherited information.*<br><br>3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.<br><br>3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment. |

## Learning Progression 2.4: Habitats and Biodiversity

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.3.5. Identify the habitats of people and familiar animals and plants and communicate their understanding that living things have different habitats. | PTK.Later.3.5. Recognize that living things have different habitats suited to their unique needs. | *In kindergarten through second grade, children build their understanding that there are many different kinds of living things in any area, on land and in water.*<br><br>2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats. | *In third through fifth grade, children build their understanding that populations live in a variety of habitats and changes in those habitats affect organisms living there.*<br><br>3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.<br><br>3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. |

# In-Practice Examples

## Learning Progression 2.2: Growth, Development, and Needs of Living Things

### Investigating the Needs and Growth of Sunflowers

The in-practice examples below illustrate how educators support children in developing their understanding of the growth, development, and needs of plants in TK and second grade (refer to the learning progression Growth, Development, and Needs of Living Things). In TK, children notice plants growing and describe the needs of plants to grow and survive. Building on this understanding, in second grade, children investigate the conditions that help plants grow, including sunlight and water. The examples illustrate how children use the science and engineering practices of asking questions, planning and carrying out investigations, analyzing and interpreting data, and formulating and communicating explanations. They also observe stability and change and gather evidence for cause-and-effect relationships, both crosscutting concepts. While the in-practice examples below are grade specific, educators in other grades can adapt similar strategies to support children in learning about the growth, development, and needs of living things.

### As you read,

Notice how children of different ages and in different grades:

- Deepen their understanding of the needs and growth of plants to survive.
- Engage in increasingly more complex investigations to explore not only the needs of plants to survive but also how different conditions, including sunlight and water, impact plant growth and survival.

Notice how educators:

- Create opportunities for meaningful science investigation related to real-life explorations with plants and enhance children's sense of belonging by connecting to children's life and home experiences with plants.
- Identify children's emerging science knowledge about plants and build on children's interests and insights.
- Support children's science discourse by asking probing questions about children's prior observations and knowledge about plants and invite multiple forms of representation through verbal descriptions and drawings in science notebooks.
- Encourage multilingual learners to use their home languages during science explorations.
- Support children with disabilities to engage actively in science investigations and contribute to collaborative learning with peers.

## Learning About the Needs of Sunflowers (Later Preschool/TK)*

Mr. Bennett has noticed that children in his TK class are excited about sunflowers in the school yard and announces that the class will go outside to explore the sunflowers. Ashlan excitedly shares, “Teacher, I saw a huge sunflower outside!” Other children chime in, “Yes, I saw it, too.” “It’s called girasol in Spanish,” shares Eduardo. Kimberly, a child with a visual impairment adds, “When I walk by the sunflowers in the morning, I like to touch and smell them.” Mr. Bennett acknowledges the children’s excitement and continues, “When we go outside, bring your science notebooks to document and label what you notice.”

Out in the garden, Mr. Bennett supports the children as they draw and label in their notebooks and prompts them to talk with peers about what they notice. With the help of a classroom aide, Kimberly feels the sunflowers, dictates what she notices, and shares with her peers. She notes that the stem feels a little fuzzy and prickly. Ashlan observes, “This sunflower is so tall and this one is small. I think it’s still a baby.” Mr. Bennett calls the group together. “Ashlan noticed that this sunflower is tall and this other sunflower is still small. What do you think the small sunflower will need to grow as big as this tall one?” Eduardo offers, “They need the sun! It’s so sunny out here.” Tani shares, “They need water! My grandma has sunflowers in her garden. I help her water them.” Mr. Bennett explains, “Over the next two weeks, we will learn more about what sunflowers need to survive and grow.”

Mr. Bennett reminds children of the meaning of “survive” and “grow” that they have learned in their past science explorations, and he draws their attention to the printed words with images, which are posted on the wall. Mr. Bennett also describes what is on the images so all children can access the visual information they present. He pairs each word with a motion and also shares the vocabulary in the languages represented in the classroom, which he has learned from the children’s families and other school staff.

Mr. Bennett places in the science center several sunflowers and library books about sunflowers for the children to explore and discuss. He reads the class several informational texts about how sunflowers grow and facilitates whole-group discussions about the content. The class conducts different experiments to investigate how sunflowers will survive with more or less sunlight and water. As the investigation progresses and the children learn more and more about the needs of sunflowers, they add drawings or tactile representations using craft materials (for example, felt pieces, pipe-cleaners, sandpaper, and so on) to their science notebooks and dictate their observations to Mr. Bennett. After they record their observations, Mr. Bennett invites them to share their ideas with each other, using questions such as “What did you observe?” and “Why do you think that?” Mr. Bennett also invites Tani’s grandmother to talk about the sunflowers in her garden and what she does to help them grow. As Tani’s grandmother shares how

* This TK in-practice example can also apply to preschool programs serving four- and five-year-old children.

often she waters the sunflowers, Ashlan asks, “Do you water them when it rains?” The grandmother smiles and responds, “That’s an important question. I don’t water them when it rains. The rain is enough for them.” The next time the class goes out to the garden, the children help water the sunflowers and Ashlan shares, “It hasn’t rained in a long time, the sunflowers need water.” As children learn about the needs of sunflowers, they continue to add drawings, tactile representations, photos, and text with help from the teacher to their science notebooks. After their investigation of the needs of sunflowers, children display their science notebooks and do a gallery walk around the classroom.

### An Investigation of the Conditions Sunflowers Need to Grow (Second Grade)

After learning about the things that plants need to thrive in different environments, Ms. Cerna works with her second-grade class to plan an investigation on how different conditions impact the growth of plants. She begins by helping children make connections to their own lives and facilitates a discussion about the conditions that children need to grow as learners. Children share their ideas like needing a caring teacher and friends they can learn from. This helps children begin to think about how conditions can affect growth. With this in mind, Ms. Cerna invites the children to make a connection to the needs of plants and asks them, “We’ve been learning about the conditions plants need to grow. What are some plants around our school you would like to learn more about?” After generating a list, the class votes to learn more about sunflowers. The class then formulates a question to lead their investigation: “What are the conditions that sunflowers need in order to grow?” Using what they learned about what plants need to thrive, Ms. Cerna asks the children to write in their science notebooks their hypotheses about environments and conditions in which sunflowers can thrive and add a drawing with labels to illustrate their ideas. Ms. Cerna provides a language frame to help the children generate their hypotheses: “I hypothesize sunflowers will grow best in ____ because ____.” After a few minutes of writing and drawing, she invites the children to take turns sharing their ideas with each other at their tables using expressions they have practiced in the past (for example, Can you say more about ____? I’d like to add to your idea ____. That’s interesting. I have a different idea: ____).

As Ms. Cerna walks around, she listens to the conversations. Samuel and Edith are discussing whether sunflowers can grow without sunlight like some of the plants they learned about. Samuel says, “Well some plants grow inside and they don’t get sunlight.” Edith responds, “Yes, but I think maybe sunflowers need a lot of sun to grow.” Samuel shares, “I wonder if they can grow in the shade when they’re outside, like they don’t get any sun.” When the children finish sharing with each other, Ms. Cerna asks a representative from each table to share one important idea their group discussed. When Edith shares, the class decides it would be interesting to find out what happens when sunflowers don’t have as much sunlight, and they make a plan to observe the sunflowers in the sunny and shady areas of the school garden. For homework and to make a connection to children’s homes, Ms. Cerna asks children to interview someone in their family or community about the conditions that help sunflowers grow.

The class plans for different groups of children to document what they observe in different parts of the garden and collect data about the sunflowers that are growing there. The children collect a number of sunflowers that are growing in an area, they make observations about how much sunlight that area of the garden gets and how dry or wet the soil is. The children make drawings, add labels, and write short descriptions of their observations in their science notebooks. When they come back to the classroom, they discuss in the larger group what they observed. Ms. Cerna says while writing on the board: “In the sunny part, the sunflowers are taller.” “The sunflowers in the shady section are a little droopy.” Rachel, a child who uses a communication device, communicates “sun” when Ms. Cerna asks them where the sunflowers were the tallest. Zenaida adds, “Some sunflowers were dying. I think maybe they need sun but also need water.” One child shares that they learned from their father who is a farmer that plants need sunlight and water to grow. After reviewing the discussion notes with the children, Ms. Cerna explains that the class will build on their initial observations by creating a graph of the different sizes of sunflowers in the garden by their location and tracking their growth in the shade and the sun.

## Highlights from the in-practice examples

**The educators enhance children's sense of belonging in science by creating opportunities to connect their learning to their home experiences.** For example, by inviting a grandmother into the classroom to talk about her flower garden or providing an opportunity for children to make connections to their own growth and learn from their families about the conditions that help sunflowers grow, the educators used **culturally sustaining** practices that contribute to children's knowing that their family experiences are sources they can draw on to learn in science. It is important to note that how we define what is alive and what is agentic or sentient varies by culture. For example, many Indigenous peoples believe that plants are agentic and sentient beings or that rocks and water are alive. This is because of different cultural orientations to the process of defining and categorizing the world around us. Educators should allow for a plurality of ideas about life and relationships in the world as they engage with learners around topics related to growth, development, and the needs of living things.

**The educators guide investigations about plants yet remain open to children's emerging science knowledge about plants and children's interest in learning about sunflowers.** This allows educators to help children learn concepts and develop practices in their investigations of the growth, development, and needs of living things, while also providing children with opportunities to explore what they are interested in learning about and connects to their everyday lives.

**The educators guide children through meaningful science investigations that focus on explorations of plants in real-world conditions** and provide children opportunities to use science and engineering practices such as recording observations, creating models, interpreting data, and formulating and communicating explanations.

**The educators support children's science discourse** by asking questions that probe children's reasoning and scientific vocabulary. Mr. Bennett asks children in TK, "What do you think the small sunflower will need to grow?" Ms. Cerna asks children in second grade to formulate a hypothesis about the conditions that sunflowers need to grow. Both educators facilitate discussions among children. The educators also support children in representing their **understanding through multiple forms of representation** in their science journals through drawings, photos, tactile images, and writing.

**The educators create a classroom atmosphere where multilingual learners feel encouraged to use their home language to express their science knowledge.** One child in Mr. Bennett's class connects to the investigation topic by sharing that sunflower is *girasol* in Spanish. Mr. Bennett works with families and other school staff to learn and share vocabulary related to their investigation of the languages represented in the classroom. He also pairs the key vocabulary with concrete examples that can help all children better understand the meaning.

Here are other ways to use children's home languages to enhance their science and engineering learning:

- Connect new vocabulary to concrete experiences. For instance, when learning about balance, challenge children to experience balancing their bodies on a low beam or ball and then offer different materials for children to make their own stable structure.
- Include books that represent children's home languages and cultures.
- Use visuals and label content around the classroom in children's home languages when possible.
- Invite children to speak with each other, teaching staff, and family members about science topics in their home languages when possible.

**The educators offer multiple entry points to explore phenomena and various modes of communication to express their insights.** The educators support the inclusion of all children, including those with disabilities and a range of learning needs, by adhering to UDL principles and providing adaptations when needed. For example, in Mr. Bennett's class, Kimberly uses her sense of touch to explore sunflowers and represents her observations using tactile creations, while in Ms. Cerna's class, Rachel shares what she observed using a communication device that has the necessary vocabulary in it.

**The educators support multilingual learners' engagement in science experiences and simultaneous English language development.**

- Both educators support writing development and equitable science discussions by providing sufficient time for children to prepare and represent their ideas through writing/composing/dictating and drawing before sharing them with peers (LLD:ELD.1.10., LLD:ELD.4.1.; ELD.PI.2.1., ELD.PI.2.10.).
- Both educators support children to effectively express ideas and share opinions with peers by structuring activities that promote sustained talk and providing formulaic expressions, such as "What did you observe?" and "Can you say more about ___?" (LLD:ELD.1.7., LLD:ELD.1.9., LLD:ELD.1.10.; ELD.PI.2.1., ELD.PI.2.3., ELD.PII.2.5.).

**Designated ELD (K–3 educators):** In addition to integrated ELD (described above), during designated ELD time, Ms. Cerna works with English learners to participate in sustained discussions with a focus on asking and responding to detailed questions (ELD.PI.2.1., ELD.PI.2.3., ELD.PII.2.5.). For example, Ms. Cerna leads a game where each child has a picture of a different kind of flower—which the other children cannot see—and is questioned by the other children about its characteristics and environment until the class is able to describe the flower and its environment in detail.

# Key Area 3: Physical Science

From preschool through third grade, children go from exploring and describing observable properties of and changes in objects and materials (their size, weight, shape, color, texture, smell, and sound) to understanding and explaining more abstract phenomena when interacting with objects and materials. Over time, children begin to understand and explain that matter is subdivided into particles. They understand and can test how forces impact an object's motion and how objects move in predictable ways. They also develop their understanding that objects of different materials allow different amounts of light to pass through and that vibrating materials can make sound. As children get to the later elementary years, they build on their understanding of the concept of energy.

## Learning Progression 3.1: Characteristics of Objects and Materials

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards* | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.2.1. Investigate and describe the characteristics and physical properties of objects and of solid and nonsolid materials (size, weight, shape, color, texture, smell, and sound). | PTK.Later.2.1. Investigate and describe in greater detail the characteristics and physical properties of objects and of solid, liquid, and gas materials (size, weight, shape, color, texture, smell, and sound). | *In kindergarten through second grade, children expand their understanding that matter can be classified by its observable properties and that different properties are suited to different purposes. They also learn that a great variety of objects can be built up from a small set of pieces.*<br><br>2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. | *In third through fifth grade, children build their understanding that matter is subdivided into particles, the amount of matter is conserved when it changes form, and measurements of a variety of properties can be used to identify materials.*<br><br>*No standards in third grade focus on these physical science disciplinary core ideas. Related standards are found in fifth grade.* |

* *CA NGSS* progression statements in this table are adapted from the Performance Expectations in the *CA NGSS*, also summarized in appendix 1 in the *Science Framework*.

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## Learning Progression 3.1: Characteristics of Objects and Materials

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| 3 to 4 ½ Years Old | 4 to 5 ½ Years Old | Kindergarten Through Grade 2 | Grade 3 |
| | | 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.<br><br>2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. | |

## Learning Progression 3.2: Changes in Objects and Materials

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.2.3. Explore and describe changes in objects and materials (for example, change in color, shape, texture, temperature), using their senses, during play and collaborative investigations, with adult support. | PTK.Later.2.3. Explore, describe, and formulate explanations of changes in objects and materials (for example, change in color, shape, texture, form, temperature), using their senses, during play and collaborative investigations, with adult support. | *In kindergarten through second grade, children build their understanding that heating or cooling a substance may cause observable changes, some of which are reversible and some of which are not.*<br><br>2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. | *In third through fifth grade, children build their understanding that when two or more different substances are mixed, a new substance with different properties may be formed and that no matter the change in the properties, the total weight of substances does not change.*<br><br>*No standards in third grade focus on these physical science disciplinary core ideas. Related standards are found in fifth grade.* |

## Learning Progression 3.3: Force and Motion

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.2.4. 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. | PTK.Later.2.4. Make and test predictions about how objects change direction, speed, or the distance they go and, based on observations, explain why objects start, stop, or change direction or speed. | *In kindergarten through second grade, children build the understanding that pushes and pulls can have different strengths and directions: pushing or pulling on an object can change the speed or direction of its motion and start or stop it, and when objects touch or collide, they push on one another, which can change their motion.*<br><br>K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.<br><br>K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. | *In third through fifth grade, children expand their understanding that forces acting on an object have both strength and direction. They also learn that objects in contact exert forces on each other. They learn that patterns of an object's motion can be observed and measured and when past motion exhibits a regular pattern, future motion can be predicted from it.*<br><br>3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.<br><br>3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. |

## Learning Progression 3.4: Light and Sound Waves

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.2.2. Explore sound, light, and shadows by manipulating objects and materials and by using their senses, during play and collaborative investigations, with adult support. | PTK.Later.2.2. Explore and describe changes in the properties of sound, light, and shadows by manipulating different objects and materials during play and collaborative investigations, with adult support. | *In kindergarten through second grade, children build their understanding that sound can make matter vibrate and vibrating matter can make sound. They also learn that objects can be seen only when light is available to illuminate them. They learn that some materials allow light to pass through, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them.*<br><br>1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.<br><br>1-PS4-2. Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated. | *In third through fifth grade, children build their understanding that waves are regular patterns of motion, waves of the same type can differ in amplitude and wavelength, and an object can be seen when light reflected from its surface enters the eyes.*<br><br>*No standards in third grade focus on these physical science disciplinary core ideas. Related standards are found in fourth grade.* |

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## Learning Progression 3.4: Light and Sound Waves

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| 3 to 4 ½ Years Old | 4 to 5 ½ Years Old | Kindergarten Through Grade 2 | Grade 3 |
| | | 1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.<br><br>1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance. | |

## Learning Progression 3.5: Energy

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.2.5. Demonstrate an awareness that things (living and nonliving) use different sources of energy to function, with adult support. | PTK.Later.2.5. Demonstrate an awareness 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, with adult support. | *In kindergarten through second grade, children build their understanding that sunlight warms Earth's surface.*<br><br>K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface.<br><br>K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area. | *In third through fifth grade, children build their understanding that energy is present whenever there are moving objects, sound, light, or heat.*<br><br>*No standards in third grade focus on these physical science disciplinary core ideas. Related standards are found in fourth grade.* |

# In-Practice Examples

## Learning Progression 3.3: Force and Motion

### Playing with Force and Motion

The in-practice examples below illustrate educators supporting children in exploring concepts of force and motion through playful experiences with rolling objects in preschool and creating and observing the behavior of pendulums in third grade (refer to the learning progression Force and Motion). In preschool, children play with rolling objects in the school playground and the educator builds on that experience by facilitating an exploration of the concepts of rolling, pushing, pulling, and how objects move in the classroom. In third grade, children investigate the patterns of motion of a pendulum through a hands-on project. In the examples, children use the science and engineering practices of carrying out investigations and developing and using models. They also explore the crosscutting concepts of cause and effect and patterns. While the in-practice examples below are grade specific, educators in other grades can adapt similar strategies to support children in learning about force and motion.

### As you read,

Notice how children of different ages and in different grades:

- Deepen their understanding of force and motion through playful, direct experiences with objects in motion.
- Make observations and predictions about objects' movement, developing an understanding of patterns in objects' movement.
- Develop increasingly more complex explanations of their observations about moving objects.

Notice how educators:

- Build on children's interests and insights that connect to children's prior experiences and observations about force and motion on the playground.
- Set up an environment with materials and objects that are accessible to all children, invite children's curiosity about force and motion, and promote inquiry-based, playful science learning about the movement of objects.
- Create opportunities for children to engage in meaningful science investigations that focus on real phenomena that children experience firsthand.
- Enhance children's sense of belonging in science by connecting learning experiences to children's home and cultural experiences related to motion.
- Create an environment in which multilingual learners' home languages are recognized and used to enhance children's learning.

## Playing with Rolling Objects (Later Preschool/TK)*

Ms. Anh notices that two children in her preschool classroom have been playing a game in the playground to see how far different balls can roll down the slide. She walks over and asks the children, "What is happening with the balls?" Asher answers, "My ball doesn't go so far, but Leann's ball is going very far." "Why do you think Leann's ball is going so far?" asks Ms. Anh. "Maybe because her ball is bigger," responds Asher. "I'm pushing it very hard, too!" exclaims Leann. "That's an interesting idea, Leann. What do you think will happen if you push yours very hard, Asher?" Asher goes to the top of the slide, and Ms. Anh says, "Before you push the ball, I want you to make a prediction. Do you think your ball will go as far as Leann's?" Asher thinks for a moment. "Yes! I'm going to push it as hard as I can." Asher pushes his ball as hard as he can. "Wow, it goes so far!" says Asher excitedly. "Did it go as far as Leann's ball? What was different this time?" asks Ms. Anh. Asher responds, "Yes! I pushed it so hard." Ms. Anh replies, "Very interesting! It sounds like how hard you push the ball can change how far it goes. Leann, I also remember Asher saying that your ball was bigger than his. Do you think that could make a difference? How could we investigate that question?"

Noticing an opportunity for children to explore changes in force and motion, Ms. Anh sets up different materials in the classroom to create ramps and different types of round objects for children to play with. She introduces the activity to the children by reading

*Oscar and the Cricket*, a book about the concepts of rolling, pushing, pulling, and how objects move. During center time, she invites a group of children, including Leann and Asher, to create ramps and investigate how far the different round objects will go. All materials are labeled in the home languages represented in the

* This preschool in-practice example can also apply to TK programs serving four- and five-year-old children.

classroom and have photos so that all children can easily know which items they have available. Over multiple days, the children explore how far marbles, tennis balls, and wooden spheres will go. Ms. Anh asks families to help children collect round items from home that they can test. Children play around with the inclination of the ramps they create out of cardboard, wooden blocks, and adjustable tracks. Ms. Anh also offers a visual representation of the steps to build a ramp for children who prefer to follow along with the visual instructions. Asher is creating a ramp and asks, "I have an idea. I'm going to make my ramp really tall!" Ms. Anh replies, "Let's try it. What do you think will happen?" "Maybe the marble will go superfast 'cause it's going down, down." "Yeah, and super far, 'cause it's going so fast," adds Leann. Asher tests the marble, and both he and Leann watch. "Wow! So fast and far!" he exclaims.

Ms. Anh helps the children record their observations on the whiteboard throughout the week and uses children's observations in songs and chants to help them make predictions and describe what is happening during their ongoing investigations. The songs have verses such as, "When I roll the marble down the ramp it goes far. When I push the ball down the ramp it goes even farther. Which sphere will go the farthest?" The chants have phrases that include "as far as." She also teaches the children gestures to accompany the song lyrics and words in the chants.

One day, Ms. Anh asks children to draw the ramp they plan to build and make predictions on the paper about how far the round objects will go. Ms. Anh engages children in conversations about their observations and even takes videos of the children that she later shows them so they can reflect on what they noticed. Ms. Anh asks, "What happened to the ball? Which one went the farthest? Why do you think it went so far? What else would you like to try?" After their ramp investigations, Ms. Anh facilitates a conversation about where the children see examples of ramps in nature or their communities to help make connections to their everyday lives. For example, one child discusses riding their scooter down a big hill. Another child remembers sledding down in the snow.

## Exploring Patterns in Motion Through Pendulums (Third Grade)

During a unit about force and motion, Ms. Youssef takes her third-grade class to the playground to observe as other children play on the swings. "What do you notice about how the swing moves?" One child states, "It moves back and forth." Another child adds, "It can go very high up and down." And yet another child notes, "The swing is hanging from the top of the swing set." Ms. Youssef points to a photograph of a swing she shows the children as she explains, "You are all making important observations about how the swing moves. Swings are examples of pendulums. A pendulum is an object attached to a point that doesn't move, much like the swings are attached to the top of the swing set. A pendulum can swing freely under its own weight, like a child swinging back and forth on the swing set." After watching others play on the swings, Ms. Youssef invites the children in her class to experience swinging themselves. After the outdoor exploration, Ms. Youssef facilitates a discussion with children about how the movement of the swings might change depending on different factors, and they formulate a question: "How do pendulums change with different lengths of the string, weights of the object, or positions of the point?" Then, Ms. Youssef shares that they can explore this question by creating their own models of pendulums in groups.

As part of the investigation, Ms. Youssef sends home an invitation for families to observe other examples of pendulums in their homes and community. The children share examples of what they observed with their family. One child describes to the class the yoyo he got from his dad, "My dad used to play with a yoyo when he was a kid in the Philippines. He taught me this trick," and demonstrates the yoyo swinging back and forth from the string. Another child shares a photo, "My grandma brought this clock with her from China.

The pendulum swings back and forth and helps to tell time." Yet another child shares, "I went to the fair with my family and we got on a ride that was like a boat that went back and forth. That's a pendulum, too." Other children were excited because they also went on that ride at the fair.

**Incorporating children's home, community, and cultural experiences and knowledge in science and engineering learning.** Educators can draw on children's cultural practices and ways of knowing to help create science and engineering experiences that are meaningful for children. Educators can engage children's families and communities as partners and resources to identify scientific phenomena that are familiar to children and can be extended as learning opportunities in the home environment. Educators can also invite family members and community experts to join science investigations and engineering projects to contribute their expertise and enrich the children's explorations of real-world phenomena. Efforts to connect to children's home and cultural experiences enhance their sense of belonging in science and help connect children's science learning to their everyday lives.

In the classroom, Ms. Youssef has set up different materials like string, weights, and wooden dowels that the class discussed to help create their pendulums in groups. In the first step, groups decide the materials they will use and create a drawing of how they would like their pendulum to look. Ms. Youssef walks around to the groups asking children about the decisions they are making. She walks to Esmeralda's group and asks, "Tell me about your pendulum." Esmeralda explains that they want their pendulum to go really far so they have made a tall structure with a long string. "What have you decided to use for your weight?" asks Ms. Youssef. "We're not sure. Something heavy maybe," answers Esmeralda. "How far do you think it will go with the long string and the heavy weight? Show me by making a mark on this paper," Ms. Youssef suggests and places a sheet of paper next to the pendulum. Children in Esmeralda's group take turns predicting how far the pendulum will go by making a mark on the paper with their pencils. "These are all good predictions. Once you start building, you can test different string lengths and weights to see how far your pendulum goes." Once the building phase begins, Ms. Youssef reviews a chart she has posted with words and phrases such as "farther/shorter/heavier than" and "as far as" and challenges children to use these words as they discuss their observations with each other. Ms. Youssef reminds the class that they can look at the pictures on the chart to remind them of the meaning of each word. As she walks around supporting children, she asks them questions about how their pendulums actually behave. "How far does your washer go on the long string? Is that what you expected?" "What happens if you change the weight at the bottom?" "What happens if you change the position of where you are letting the weight go?" When Ms. Youssef returns to Esmeralda's group, she learns that they decided to shorten the string and keep the heavier weight. "The string was too long and our pendulum wasn't going so far," explains Esmeralda. As children work on their pendulums, Ms. Youssef asks them to draw or write their observations. After their explorations, Ms. Youssef suggests that in the next few days the class will conduct investigations to predict and test the motion of pendulums with longer versus shorter strings and heavier or lighter objects.

## Highlights from the in-practice examples

**The educators build on children's interests and insights** from the playground that connect to children's exploration of force and motion in the classroom.

**The educators set up materials and objects that invite children's curiosity** about force and motion and **promote inquiry-based, playful science learning** about the movement of objects. Ms. Anh sets up materials for children to create their own ramps and explore different rolling objects. Ms. Youssef invites children to make observations of the swings and play on the swings themselves to draw conclusions. Ms. Youssef also provides many different materials that children can use to create their pendulums and experiment with different factors that impact their movement. Using visual labels and representations on materials also follows UDL principles and makes content accessible to all children, including those with disabilities. Ms. Anh provides a visual representation of the steps children can follow to build a ramp that can be a support for children who need additional support. Ms. Youssef pairs key vocabulary with pictures for children's reference during their discussions.

**The educators create opportunities for children to engage in meaningful science investigations that focus on real phenomena** that children have experienced on the playground and can reference during their exploration and predictions about the motion of objects (for example, rolling balls down the slide or playing on a swing set).

**The educators enhance children's sense of belonging in science.** Ms. Anh facilitates a conversation about where children have seen examples of ramps in their everyday lives. Ms. Youssef invites children to find examples of pendulums in their own homes, family experiences, and cultures.

Here are other ways to use culturally sustaining practices to enhance children's sense of belonging in science and engineering:

- Be sure to allow for multiple cultural orientations as children explore and make meaning of phenomena. For instance, it is important to note that what is considered an "object" versus a "subject" is cultural. For many Indigenous people, rocks are not objects—they are beings with a spirit.
- Learn from families and local communities about objects, native plants, or natural materials that are of special cultural significance and use them as entry points or concrete experiences for children.
- Use stories and narratives from children's cultures to introduce and extend science and engineering learning experiences.

- Offer references to solutions created by different cultures or in different countries to inform children's engineering design solutions.

**The educators create an environment in which multilingual learners' home language is recognized and used to enhance children's learning.** Ms. Anh labels materials with the home languages represented in the classroom and with photos that make it clear what materials are available. The labels in the home languages help to remind adults to use the languages and foster a multilingual classroom culture.

**The educators support multilingual learners' engagement in science experiences and simultaneous English language development.**

- Ms. Anh supports the children to understand and use new vocabulary for categories (far, farther, farthest) and complex grammatical structures (as far as) by teaching the children songs and chants with the new language in them (LLD:ELD.1.1., LLD:ELD1.2., LLD:ELD.1.4.).
- Ms. Youssef also supports the children to understand and use new vocabulary for categories (farther/heavier/stronger than) and complex grammatical structures (as far as) by providing a chart with the language for the children to refer to (ELD.PI.3.6., ELD.PI.10b., ELD.PI.3.12b., ELD.PII.3.5.).

**Designated ELD (K–3 educators):** In addition to integrated ELD (described above), during designated ELD time, Ms. Youssef works with English learners to select key words and use adjective phrases to describe their science observations in detailed sentences (ELD.PI.3.10b; ELD.PII.3.5). Throughout the week, the children engage in learning experiences as scientists observing and describing in detail objects in motion and recounting their science experiences.

# Key Area 4: Earth and Space Science

From preschool through third grade, children experience and learn about the characteristics of earth materials and observe how celestial bodies (sun, moon, stars) and weather behave. As children enter early elementary years, their prior experiences with earth materials inform their learning about bodies of water and their understanding that water can exist in ice or liquid form. They also learn how wind and water can change the shape of land. Children figure out that land and water are represented in maps. In the early elementary years, children also use their prior knowledge of celestial bodies and weather to keep track of patterns and make predictions about changes in the moon, stars, and sun and the weather. They also learn about the solar system. Children grow in their understanding of the impact of human activity on the environment, land, and water and how people can help protect Earth.

## Learning Progression 4.1: Characteristics of Earth Materials and Systems

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards* | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.4.1 Investigate and describe the characteristics (for example, size, weight, shape, color, texture) of earth materials such as sand, rocks, soil, water, and air. | PTK.Later.4.1 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). | *In kindergarten through second grade, children build their understanding that wind and water can change the shape of the land. They also learn that water is found in the ocean, rivers, lakes, and ponds and can exist as solid ice or in liquid form. They learn that maps show the shapes and kinds of land and water in any area.*<br><br>2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.<br><br>2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.<br><br>2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid. | *In third through fifth grade, children build their understanding that rainfall, water, ice, wind, living organisms, and gravity shape the land and affect living things found in a region. They also learn about Earth's major systems and how they interact to affect Earth's surface materials and processes.*<br><br>*No standards in third grade focus on these earth and space science disciplinary core ideas. Related standards are found in fourth and fifth grade.* |

* *CA NGSS* progression statements in this table are adapted from the Performance Expectations in the *CA NGSS*, also summarized in appendix 1 in the *Science Framework*.

## Learning Progression 4.2: Earth's Place in the Universe

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.4.2. Observe and describe natural objects in the sky (sun, moon, stars, and clouds) and how they appear to move and change. | PTK.Later.4.2. Observe and describe natural objects in the sky and describe patterns of movement and apparent changes in the sun, moon, stars, and clouds. | *In kindergarten through second grade, children expand their understanding that patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. They also learn that seasonal patterns of sunrise and sunset can be observed, described, and predicted.*<br><br>1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.<br><br>1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year. | *In third through fifth grade, children build their understanding that the sun is a star and that stars range in their distance from Earth. They also learn that the orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis, cause observable patterns, such as day and night, daily changes in the length and direction of shadows, and the positions of the sun, moon, and stars at different times of the day, month, and year.*<br><br>*No standards in third grade focus on these earth and space science disciplinary core ideas. Related standards are found in fifth grade.* |

## Learning Progression 4.3: Weather and Climate

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.4.3. Notice and describe changes in weather. Notice the effects of weather and seasonal changes on their own lives and on plants and animals. | PTK.Later.4.3. 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. | *In kindergarten through second grade, children expand their understanding that weather is the combination of sunlight, wind, snow or rain, and temperature in a region at a particular time. They also learn that people measure these conditions to describe and record the weather to notice patterns over time.*<br><br>K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. | *In third through fifth grade, children build their understanding that climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over the years. They also learn that scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.*<br><br>3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.<br><br>3-ESS2-2. Obtain and combine information to describe climates in different regions of the world. |

## Learning Progression 4.4: Earth and Human Activity

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.4.4. 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. | PTK.Later.4.4. 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. | *In kindergarten through second grade, children expand their understanding that humans use natural resources for everything they do. They also learn that the things that people do to live comfortably can affect the world around them and that people can make choices that reduce their impacts on the land, water, air, and other living things.*<br><br>K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. | *In third through fifth grade, children build their understanding that the energy and fuels that humans use are derived from natural sources and their use affects the environment in multiple ways. They also learn that human activities have major effects on the land, vegetation, streams, ocean, air, and even outer space and individuals and communities are doing things to help protect Earth's resources and environments.*<br><br>*No standards in third grade focus on these earth and space science disciplinary core ideas. Related standards are found in fourth and fifth grade.* |

# In-Practice Examples

## Learning Progression 4.1: Characteristics of Earth Materials and Systems

### Learning About Earth Materials and Landscapes

The in-practice examples below illustrate how educators facilitate children's hands-on learning to explore earth materials found in different landscapes in kindergarten and develop 3D models and maps of landscapes in second grade (refer to the learning progression Characteristics of Earth Materials and Systems). Children use the science and engineering practices of planning and carrying out investigations and developing and using models. In these in-practice examples, children engage with the crosscutting concept of systems and their interactions. While the in-practice examples below are grade specific, educators in other grades can adapt similar strategies to support children in learning about the characteristics of earth materials and systems.

### As you read,

Notice how children of different ages and in different grades:

- Develop their understanding of the earth materials found in different habitats and their ability to represent them using models.
- Observe and use what they already know from experience as they learn.

Notice how educators:

- Set up an environment that invites curiosity and promotes inquiry-based, playful learning about earth materials and different landscapes.
- Support children's science discourse about their observations of different earth materials and provide multiple ways for children to represent their knowledge.
- Enhance children's sense of belonging in science by connecting learning experiences to children's everyday life, home, and cultural experiences.
- Engage children with disabilities in science learning in meaningful ways.
- Create an environment in which multilingual learners' home languages are recognized and used to enhance children's learning.

### Exploring Earth Materials from Different Landscapes (Kindergarten)

Teacher Paola's kindergarten class has been learning about the characteristics of different landscapes: the ocean, desert, forest, and mountains. After learning about each landscape, the children participate in creating centers with earth materials from that landscape. This week the children are learning about mountains. During circle time, Teacher Paola reads a picture book about mountains and invites children to share the connections they make to their own lives. "Has anyone been to the mountains before? What did you observe there?" she asks. One child responds, "There were a lot of rocks." Another child answers, "And dirt." A child shares, "My reservation is near a mountain. There are big rocks and caves. I go play there with my cousins and my uncle." Teacher Paola announces that today the children will be helping to create centers using earth materials (for example, rocks, soil, minerals) that children helped collect from families and community members. In the process of collecting materials, the teacher encourages families to have conversations about their own cultural connections to land, mountains, and earth materials. Teacher Paola invites children to share what they learned from their families as they collected the materials. In each center, children place the materials they brought and Teacher Paola adds related books, images, and audio recordings.

The next day, children visit each center they helped create and explore the materials available. At one of the centers, Karim is holding two different rocks. Teacher Paola walks over and asks, "What are you noticing?" Karim points to the drawing he made and explains, "This one has pointy parts. This one is smooth." "Have you ever seen rocks like this anywhere else?" "Yes, when I go hiking with mom and dad, I collect rocks like this one [pointing to the rock with sharp edges]. I find them on the path." "I have seen rocks like that when I hike in the mountains, too," responds

**Planning for the participation of children with disabilities in science and engineering learning activities.** Educators can plan science and engineering learning experiences that incorporate a wide variety of experiences, materials, and equipment to increase the access and participation of children across a broad range of individual differences and abilities, including children with disabilities. Educators can consider the different ways in which children with disabilities might engage in a learning activity and the additional support they may need to demonstrate their knowledge and skills. Children with disabilities may need additional accommodations and modifications to demonstrate their knowledge and skills. For example, they may use adaptive equipment to engage in learning activities or assistive technologies to communicate their understanding. Educators should provide specific supports to meet the needs of children with disabilities in accordance to their Individual Family Service Plan, Individualized Education Program, or 504 plan.

Teacher Paola. “How about smooth rocks like this one?” asks Teacher Paola. Karim shares that he has not seen rocks like that before. Teacher Paola offers Karim the book on mountains and reads a section that explains that smooth rocks like that can be found near rivers in the mountains.

Liam, a child with autism, is playing with soil in a dirt box. When Teacher Paola walks over and asks, “What are you noticing?” Liam takes a fistful of soil and then lets it go slowly. “The soil is loose and it has so many little parts,” comments Teacher Paola. Noticing how much Liam likes putting his fingers in the soil, Teacher Paola adds, “The soil is soft.” To support Liam’s transition to the next center, Teacher Paola uses a timer that helps Liam know how much time is left in each center. Teacher Paola has a visual schedule at the children’s eye level that helps Liam and all the other children know the order they are following throughout the day. When center time is over, children begin cleaning up and Teacher Paola shows Liam a “first, then” card to remind him he will first clean up, then move to circle time. She then brings the group together to reflect on what they observed. She brings up the different earth materials that children explored and invites them to describe and point out similarities and differences in their size, shape, color, and texture. She introduces cards with words and images representing different descriptions (big, small, smooth, rough, wet, dry) and has the children say the words chorally and do a gesture with her as she holds up each card. She then invites different children to choose a card and place it in front of one of the materials it describes. When it’s Liam’s turn, he picks the card representing “smooth,” and places it in front of the soil. Teacher Paola also asks children to point out similarities and differences between the materials (for example, some rocks are rough and others are smooth) and shares some information about what children notice (for example, rocks from the river are smooth because the current smooths them out).

## Creating Maps to Represent Different Landscapes (Second Grade)

In learning about earth materials and systems, Ms. Huang plans a long-term project for her second-graders to develop a model to represent the features of the land and bodies of water in an area that is local and meaningful to children. To begin the project, the class reads an informational text about the purpose of maps, how maps might be formatted, and how maps depict different forms of land and bodies of water in a landscape. Ms. Huang has collected maps from families, especially of places that are meaningful to them, and children spend time exploring the maps, noticing their different features, and discussing their purpose. Ms. Huang also shows maps that depict different landforms using textures. The water feels smooth, and the mountains are raised and bumpy. Ms. Huang then shares different maps of the city where the school is located with different groups and then asks children to move from table to table making observations. With her help, children identify different landforms and bodies of water that are familiar to them from around the city. Ms. Huang asks the children, “What similarities and differences between the maps did you notice?” One child comments, “I could tell that different parts were water and others were land.” “How did you know that?” asks Ms. Huang. The child responds, “Well, they were different colors, and on this map the water was blue and felt smooth.” Another child adds, “And some maps had this box that told you what each color is.” Ms. Huang, “Yes, maps use different shapes and colors to indicate differences in the landscape, and the box called a ‘legend’ gives you information about what different colors or shapes represent.” With the help of other teaching staff and families, Ms. Huang shares with children some key vocabulary such as map, land, mountains, ocean, and river in the home languages represented in the classroom. She also shares the vocabulary in the language of the Indigenous people of the lands they occupy.

Ms. Huang explains that they will be creating their own map of a place that is important to them. Before they begin, Ms. Huang facilitates a group discussion about what makes a useful map based on the maps they have studied. After the class has created a list of aspects of useful maps, Ms. Huang explains, “For our project, you are going to think of a place that is important to you and then create a map that represents it.” Children work in groups to discuss the landscape features they need to include in their place map—whether they should have rivers, oceans, mountains, forests, deserts, or other features. Children work excitedly over multiple days with the support of the teacher, planning and then modeling using the materials available. When the landscape models are complete, children draw their maps. Ms. Huang walks around supporting children in making decisions about how to best represent the different aspects of their landscape. Ms. Huang notices that one child is struggling to decide how they would like to represent a mountain on their map. Felix wants to draw mountains on the map. Another child, Maleka, suggests that he use contour lines the way she saw in the map examples the class studied at the beginning of the project. “Nobody is going to know what that means. The mountains make more sense,” explains Felix. “But real maps use the circles,” responds Maleka. Ms. Huang asks Felix and Maleka, “What is one way that maps help people know what each part of the map means?” Another child at the table responds, “That is another thing that makes a useful map! We can use a legend.” Felix draws the mountains on the map and uses the legend to represent all the parts of the map. At the end of the project, Ms. Huang invites each child to orally present their map and explain why the place is important to them. As an extension, Ms. Huang organizes a game in which children match the maps others created to the corresponding model.

## Highlights from the in-practice examples

**The educators set up an environment that invites curiosity and promotes inquiry-based, playful learning** about earth materials and different landscapes. The centers that children help create in Teacher Paola's classroom aid in building connections between children's prior experiences and the hands-on, playful exploration of earth materials. Ms. Huang makes different kinds of materials available for children to create a 3D model of their own landscape and create maps of their 3D models.

Here are other ways to create environments that invite curiosity about science and engineering:

- Make natural materials (for example, minerals, rocks, leaves, shells, flowers) available for children that invite them to use their senses to explore and that generate questions about the local natural world.
- Connect with community resources and families to identify objects that might spark children's interest and curiosity (for example, binoculars, glass prisms, instruments).

**The educators support children's science discourse and use multiple forms of representation.** Teacher Paola asks children to share and compare their descriptions of different earth materials with each other using description cards. Ms. Huang guides children in discussing the characteristics of useful maps and creating 3D models and maps to represent the features of different landscapes.

**The educators enhance children's sense of belonging in science by inviting children to make connections between the science topic and their everyday life, home, and cultural experiences.** This helps children see their home and cultural experiences as meaningful sources of knowledge as they learn about science in school. In Teacher Paola's class, she asks questions that help children make connections between their own lives and their exploration of mountains. For instance, one child draws on their experience of exploring mountains on their reservation with their uncle and cousins as they learn about earth materials in that landscape. Ms. Huang uses maps that are provided by families of places that are meaningful to them and invites children to create a model and map of a place that is important to them and their families.

**The educators engage children in meaningful science learning by offering the individual supports they need to actively participate in the activity.** For example, Teacher Paola implements UDL principles to represent information and promote self-regulation when using a visual timer, "first-then" visual, and visual schedule to set expectations while children transition between centers. She also uses visual cards for all children to communicate their observations. Ms. Huang offers visual and tactile representations of maps for children to explore.

**The educators leverage multilingual learners' home languages.** Ms. Huang works with other teaching staff and families to introduce key vocabulary such as map, land, mountains, ocean, and river in the home languages represented in the classroom. This helps to enhance multilingual learners' knowledge of the content while they make connections to what they already know in their home languages.

**The educators support multilingual learners' engagement in science experiences and simultaneous English language development.**

- Teacher Paola supports the children to exchange ideas and offer opinions by providing cards with words and images for describing, such as smooth and rough, having the children chorally say a language frame with her (Maybe ____ because ____), and modeling how to use the language in peer-to-peer discussions (ELD.PI.K.1., ELD.PI.K.3., ELD.PI.K.12b., ELD.PII.K.6.).
- Ms. Huang supports the children to read maps closely and describe their characteristics by facilitating a small-group discussion about what makes useful maps (ELD.PI.2.1., ELD.PI.2.6., ELD.PI.2.9.).

**Designated ELD (K–3 educators):** In addition to integrated ELD (described above), during designated ELD time, the educators work with English learners to describe their science observations using detailed sentences and precise vocabulary. For example, Teacher Paola helps the children use expanded noun phrases as they describe how earth materials in their "mystery bags" feel, sound, and smell (ELD.PI.K.6., ELD.PII.K.4.). Ms. Huang supports the children to use expanded noun phrases and precise vocabulary to describe the kinds of land and bodies of water on maps representing all the different countries where the children or their families were born (ELD.PI.2.6., ELD.PII.2.4.).

# Key Area 5: Engineering, Technology, and Applications of Science

From preschool through third grade, children grow in their ability to identify problems and design various solutions to problems. As they develop their understanding of how problems can be solved through engineering design, they become more adept at testing their solutions and comparing multiple solutions to a problem.

## Learning Progression 5.1: Engineering Design

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards* | |
|---|---|---|---|
| **3 to 4 ½ Years Old** | **4 to 5 ½ Years Old** | **Kindergarten Through Grade 2** | **Grade 3** |
| PTK.Early.5.1. Engage collaboratively with peers and adults in the engineering design cycle by identifying problems in play and everyday activities, by planning and creating simple solutions, and, with adult support, by testing and refining their solutions.<br><br>PTK.Early.5.2. Notice and explore how tools and design solutions help address their own and other people's needs and goals in everyday life. | PTK.Later.5.1. Engage collaboratively with peers and adults in the engineering design cycle by identifying problems in play and everyday activities, by planning and creating more detailed solutions and by testing and refining their solutions more independently and over longer periods of time.<br><br>PTK.Later.5.2. 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. | *In kindergarten through second grade, children expand their understanding that what people want to change or create can be approached as a problem to be solved through engineering. They deepen their understanding that because there is always more than one possible solution to a problem, it is useful to compare and test designs. They also convey their designs through sketches, drawings, or physical models.*<br><br>K–2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. | *In third through fifth grade, children build their understanding that possible solutions to a problem are limited by available materials and resources (constraints) and the success of a designed solution is determined by considering the desired features of a solution (criteria). They also learn to test different solutions by comparing how well each one meets the specified criteria or constraints of a problem.*<br><br>3–5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. |

* *CA NGSS* progression statements in this table are adapted from Performance Expectations in the *CA NGSS*.

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## Learning Progression 5.1: Engineering Design

| Preschool/Transitional Kindergarten Learning Foundations | | California Next Generation Science Standards | |
|---|---|---|---|
| 3 to 4 ½ Years Old | 4 to 5 ½ Years Old | Kindergarten Through Grade 2 | Grade 3 |
| | | K–2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.<br><br>K–2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. | 3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.<br><br>3–5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. |

# In-Practice Examples

## Learning Progression 5.1: Engineering Design

### Using Engineering Design to Solve Problems

The in-practice examples below illustrate how educators support children in using their emerging engineering design skills to solve problems they face in play and their school community (refer to the learning progression Engineering Design). In preschool, children solve a problem in the outdoor sandbox. In second grade, children propose solutions for a problem impacting the school garden. In the examples, children use the science and engineering practices of defining problems, developing and using models, and formulating and communicating explanations and solutions. They also explore structure and function and cause and effect, two crosscutting concepts. While the in-practice examples below are grade specific, educators in other grades can adapt similar strategies to engage children in engineering solutions.

### As you read,

Notice how children of different ages and in different grades:

- Define increasingly more complex problems and test out different solutions that are relevant to them and their community.
- Use models to represent their engineering design ideas.

Notice how educators:

- Create opportunities for children to engage in meaningful engineering problems that address pressing issues in their lives and communities.
- Enhance children’s sense of belonging in engineering by building on children’s interests and insights and connecting learning experiences to children’s families.
- Set up an environment that invites curiosity and promotes inquiry-based, playful engineering design experiences.
- Support children with disabilities’ engagement in planning and developing engineering solutions.
- Create an environment in which multilingual learners feel welcome to use their home languages to engage in engineering activities.

## Making the Sandcastle Accessible to Everyone (Preschool)

Rodney and Lily from Ms. Holy's preschool class (ages three and four years old) have been working on building a sandcastle in the sandbox when Rodney stops and asks, "How will Ms. Holy get in the castle? Her wheelchair can't go upstairs." Ms. Holy hears Rodney and comments, "Seems like you have an engineering problem. What can you and Lily build so that wheelchairs can get into the castle?" "We can build a ramp!" suggests Lily. "Oh, yes! Like the one outside our classroom," responds Rodney. "That's a great solution," says Ms. Holy. She then asks, "What materials can you use to build the ramp?" Rodney and Lily collect tree bark, twigs, and rocks from nearby and begin placing the materials at an angle against the sandcastle. When Ms. Holy notices that the ramp is still not staying up, she prompts the children, "I notice that your ramp is not quite staying in place. What else might you try to help it stay?" "Maybe we can put some more rocks under and to the side," suggests Lily. "Yes. The rocks can make it strong," adds Rodney. Lily and Rodney work together to put rocks underneath the ramp and then twigs and rocks on either side of the ramp to make it stable. Ms. Holy takes photos as the children build and sets up a corner to showcase their work. Ms. Holy elevates the engineering process (of identifying a problem, planning a solution, and testing the solution) for the whole class by inviting Rodney and Lily to share what their problem was and the solution they developed. She supports Rodney and Lily to recount their experience by placing the photos in a pocket chart in order. She also offers language frames that they can use (such as First ____, After that ____, Next ____, Then ____) to elaborate on and clarify their explanations.

## Solutions to Stop the Garden from Flooding (Second Grade)

Mr. Silva's second-grade class has been learning about how wind and water can change the shape of land, and children have been commenting on the flooding in the school garden because of the recent rains. To connect their learning to a real-life problem, Mr. Silva presents a design challenge to the class. "As you know, it's been raining a lot in our area and parts of our school are getting flooded. How do you think we can address this challenge and come up with solutions to prevent the school garden from getting flooded?" Mr. Silva reminds the class that they will be coming up with solutions like the engineering figure they have been learning about, Howard P. Grant, who was the first Black graduate of the University of California, Berkeley, College of Engineering and was the first Black engineer for the city and county of San Francisco. Mr. Silva engages children in a discussion about possible solutions to the flooding problem. After the children have shared ideas, Mr. Silva goes on to explain that the children will work in groups to plan, design, and test a solution to this problem and they will orally present their designs to the principal to help her decide what to do.

On a day when it has stopped raining and it is safe to investigate, the children go outside to study the garden and where rainwater has been accumulating. Mr. Silva takes photos of the garden and the observations children make. When the class goes back inside, Mr. Silva projects the photos so the children can refer to them as they brainstorm solutions.

After brainstorming as a class, Mr. Silva provides groups with different materials and tools to create a simple sketch, drawing, or physical model of their proposed solutions. As Mr. Silva walks around the room, he listens to the children's plans. One group plans to use a barrel with a hose attached to it to catch rainwater coming down from the roof and divert it to the larger lawn area in the schoolyard. A pair of children in another group excitedly speak in Tagalog about their solutions, and Mr. Silva comments, "I see you're excited about your proposed solution. What are you planning?" The children explain that they are planning to create umbrellas for the school garden using tarps and tubing. Yet another group decides they want to create sandbags that will cover the area around the garden to help keep the water out. One group struggles to come up with a solution. Lingling explains, "I'm thinking of some kind of ramp. What if we make like a ramp next to the garden so the water goes down and away from the garden and not into the garden." Oscar responds, "I'm not sure how that would work." Lingling continues explaining, "It would be like some kind of plastic that would go like this [she draws a 45-degree angle] so the water would go away from the garden and then would not be able to come back into the garden to flood it." Noticing the trouble the group is having, Mr. Silva encourages the group to use other materials available to make a simple 3D model of the solution Lingling is suggesting. Oscar, a child with attention deficit hyperactivity disorder, uses a bouncy ball while he participates in the group activity. The group finalizes the details of their solution together and Lingling's group decides to give the solution a try and call it, "the rain ramp."

In preparation for testing the solutions outdoors, Mr. Silva invites Keisha's mother, who is a landscaper, to help the groups create and test their solutions. On the day the groups go outside, Lingling's group discovers that their solution requires plastic tubes to keep it upright and tarp material to help seal the bottom and prevent

the water from coming back into the garden. Groups take turns presenting their solutions, and Mr. Silva invites the rest of the class to make comments about the strengths and weaknesses of each solution. During their oral presentations, each group recounts their experience finding a solution using their drawings and models. Mr. Silva provides the children with vocabulary they can use in their presentations, such as “problem” and “solution.” He also provides language frames for connecting events cohesively and explaining reasons for specific decisions (First we ____ because ____, Then we ____ because ____, After that, we ____), as well as for introducing issues they ran into (However, ____, Suddenly, ____, Unfortunately, ____, We were surprised when ____). After Lingling’s group presents, children comment on the clever and fun idea Lingling’s group came up with. They like the idea of the ramp being at a 45-degree angle, allowing the water to fall away from the garden and preventing it from flowing back in. However, some children wonder if this solution will be enough for a heavy downpour and suggest using putty to seal the bottom of the ramp.

## Highlights from the in-practice examples

**The educators engage children in meaningful engineering problems that address pressing issues in their lives and communities.** For children in preschool it can be a problem that emerges during play in the sandbox, and for second graders it can be coming up with solutions to save the school garden from flooding. In both of these examples, children use their engineering design skills to address a problem with real-world consequences in which they are personally invested.

**The educators enhance children's sense of belonging in engineering by building on children's interests and insights and connecting learning experiences to children's families.** Ms. Holy identifies the moment in the sandbox as an opportunity to prompt children to use their engineering design skills to solve their own problems. Mr. Silva builds on the children's observations of the flooding that has been occurring in their area to engage children in solving a problem that will address a need in their school community. Mr. Silva also invites family members to participate in science learning experiences.

**The educators set up an environment that invites curiosity and promotes inquiry-based, playful engineering design experiences.** Ms. Holy uses the context of outdoor play and natural materials to promote children's engineering design skills. Mr. Silva offers children different kinds of materials to model, create, and test their solutions.

**The educators use strategies and supports that enhance children with disabilities' engagement in engineering design experiences.** Mr. Silva has planned for the accommodations and modifications that children with disabilities require in their learning. Oscar knows he can use the bouncy ball while he works with his team.

Here are other ways to support children with disabilities' participation in science and engineering experiences:

- Offer adaptive equipment and tools that children can use to participate actively in science and engineering activities. For example, when digging in the sand or the school garden, a child with a physical disability might benefit from using an adaptive shovel.
- Consider how a science phenomenon or engineering design solution might be experienced through different senses. For example, when learning about different habitats, offer visuals, sounds, and objects that children can relate to the habitats they are learning about. When designing a solution to a problem, offer different materials with different features (for instance, color, texture, size) that children can use to show their ideas and design solutions.
- Facilitate and encourage children to express their knowledge in a variety of ways, including drawing, actions,

or assistive communication devices for children with disabilities to express their knowledge.

- Adapt the instructions as needed. For example, break down a task or activity into smaller steps or offer visual supports such as “first, then” boards to illustrate sequences required within tasks.

**The educators create an environment in which multilingual learners feel welcome to use their home language to engage in engineering activities.** In Mr. Silva’s class, children feel comfortable speaking in their home language in their discussions about their engineering solutions. Mr. Silva notices their excitement and invites them to share their ideas with him, acknowledging the importance of the reasoning and planning they are doing in their home language. In some instances, educators can pair children who share the same home language to create opportunities for multilingual learners to discuss their engineering solutions in their home language.

**The educators support multilingual learners’ engagement in science experiences and simultaneous English language development.**

- Both educators support the children to access new content and orally recount their experiences by providing multimodal support, such as photos, drawings, and 3D models, for the children to refer to (LLD:ELD.1.3., LLD:ELD.1.8.; ELD.PI.2.9., ELD.PI.2.12a.).
- Both educators support the children to orally present their engineering experiences in order and with precision by providing charts with academic vocabulary, such as “problem” and “solution,” and language frames containing text connectives, such as “First ____, Then we ____ because ____, We were surprised when ____” (LLD:ELD.1.2., LLD:ELD.1.3., LLD:ELD.1.8.; ELD.PI.2.9., ELD.PI.2.12a., ELD.PII.2.1., ELD.PII.2.2.).

**Designated ELD (K–3 educators):** In addition to integrated ELD (described above), during designated ELD time, Mr. Silva works with English learners to use text connectives to orally recount engineering experiences in order (ELD.PII.2.1., ELD.PII.2.2.). For example, Mr. Silva has the children play together in partners to construct buildings, bridges, and other structures with objects and natural materials families brought from home and prompts them to tell each other what they are doing as they build. Afterwards, each pair of children recounts how they built a structure using text connectives that Mr. Silva provides on charts and through oral prompting.

# Appendix A

## Supporting English Language Development Across the P–3 Continuum

Multilingual children in California schools and early education programs are developing proficiency in both English and one or more other languages. Supporting multilingual learners' language development involves promoting the continued development of the home language and English. Regardless of the language or languages used during instruction, linguistically sustaining educators are aware that multilingual children's home languages are valuable personal, intellectual, and community resources.* They recognize that children are at risk of losing their home language competence as they develop their English language skills. Linguistically sustaining educators also acknowledge the importance of supporting the development of the heritage language for children from Native nations and tribal communities that are engaged in language revitalization efforts. Children's home language development is foundational to learning additional languages. Educators can create classroom environments that invite children's use of home languages and heritage languages throughout the day. Educators can also encourage families to maintain and continue to develop the home languages and heritage languages in their communities as children add English to their linguistic repertoires. Overall, children's multilingualism should be valued as an asset.

For many multilingual learners, the P–3 school environment is the primary context for learning English. English language development (ELD) instruction provides equitable access to, and meaningful participation in, learning activities conducted in English and supports children's steady progress toward full proficiency in the English language. In preschool and transitional kindergarten (TK) programs, educators integrate ELD throughout daily routines and classroom activities. In K–12, educators take a comprehensive approach to ELD instruction, which includes both integrated ELD (instruction that occurs throughout the day in all content areas) and designated ELD (dedicated ELD instructional time).**

### Teaching Strategies to Support English Language Development

Educators use engaging and interactive teaching strategies to support ELD using a culturally and linguistically sustaining approach. While particularly helpful when supporting English learners, the following strategies can benefit all children's learning:

* Chapter 3 in *Improving Education for Multilingual and English Learner Students* provides an overview of language acquisition program models and pedagogical approaches.

** Integrated and designated ELD are explained in chapter 2 in the *English Language Arts/English Language Development Framework* (CA ELA/ELD Framework). Content referencing transitional kindergarten should be used alongside the *Preschool/Transitional Kindergarten Learning Foundations*.

- **Hands-on learning:** Engage children in experiential learning activities where they interact with the content actively and in collaboration with peers. For example, children engage in a science investigation in which they use three-dimensional models to share what they have observed or use art to create a visual representation of what they learned about a topic. These opportunities deepen understanding of content and provide authentic opportunities for children to practice their English.
- **Props and concrete objects:** Use concrete objects and materials, including props, visual representations, and costumes, to help children learn new vocabulary in English and make meaning about new topics. For example, invite children to reenact a story or invent a new story using props. Using these materials helps children deepen their understanding of content presented in English. It also presents an opportunity to practice using content-related language they are learning in English, including vivid vocabulary and dialogue.
- **Protocols and discussion norms:** Provide protocols with clear roles and steps or norms for participating in discussions in English. Providing protocols or discussion norms helps children engage meaningfully in productive discussions, reinforces their discussion skills such as turn taking, and strengthens their English language proficiency as speakers and listeners.
- **Language frames:** Provide and model the use of language frames in English (for example, "I think ____, because ____."). Language frames should be developmentally and linguistically appropriate and over time can contain increasingly complex grammatical structures or reference word banks for specific parts of speech (for example, "I think the character was behaving ____ + adverb because ____." *Adverb word bank: selflessly, recklessly, selfishly, angrily*). Language frames introduce language patterns and academic terms that children can then use, unprompted, in spoken and written English. This helps them to express themselves effectively and expands their grammatical knowledge.
- **Think-pair-share:** Provide children opportunities to discuss an idea or solution to a problem with a partner in English after they have had a chance to think about it independently. This peer-to-peer discussion strengthens children's use of English and expands their conceptual understanding. Think-pair-share also supports children in rehearsing the language they might later use in a whole-group setting. It is important to structure the think-pair-share with a protocol that sets expectations for listening, speaking, and using conversation norms.
- **Vocabulary instruction:** Use explicit instructional routines to help children learn new academic vocabulary in English and model appropriate use of vocabulary. Encourage them to use the words over time in various activities, such as in the context of hands-on learning activities or free play with peers. This instruction helps children learn the words deeply so they can use them intentionally in speaking and writing.
- **Songs, chants, and gestures:** Use songs or chants in English about a novel concept or topic, using new vocabulary and gestures. This use reinforces children's conceptual understandings and strengthens their ability to use new vocabulary in English.

- **Wide reading:** Provide high-quality children's literature from different genres and informational texts on diverse topics to help build children's knowledge about language and content in English. To ensure children see themselves reflected and represented in texts, choose texts that are relevant to children's families and communities and are written by authors from those communities. Support children through educator read-alouds, independent reading, and shared reading experiences with other children (for example, engaging in small-group discussions about a text). These practices enhance children's literacy skills, vocabulary expansion, and content knowledge.
- **Graphic organizers and visual supports:** Incorporate graphic organizers with language supports and visuals as scaffolds during learning activities conducted in English. Educators might provide graphic organizers that contain visuals or descriptions of key vocabulary in a text or language frames to support children's discussions or written responses to the text. These materials support children's comprehension of English texts and productive spoken and written language in English.
- **Translanguaging:** Offer opportunities for children to leverage all their linguistic resources, including the home language or other languages the child uses, whether instruction is provided in English, their home language, or another language the child uses. Translanguaging, when children combine and integrate languages they know when communicating, is a natural part of being multilingual that helps with learning. For example, educators can pair children who share the same home language in a think-pair-share activity to discuss an idea before sharing it in a small group.

# Appendix B

## Additional Resources

**Key Area 1: Science and Engineering Practices**

For extended vignettes on how children use science and engineering practices to explore earth and space science phenomena, refer to the following:

*California Preschool Curriculum Framework, Volume 3* (Additional resources from the *Preschool Curriculum Frameworks* should be used alongside the current *Preschool/Transitional Kindergarten Learning Foundations*)

- Vignette, p. 221
- Vignette, p. 224
- Bringing It All Together, p. 227

*Science Framework for California Public Schools*

- Kindergarten Instructional Segment 3: Weather Patterns, p. 120
- Grade One Instructional Segment 3: Shadows and Light, p. 150
- Grade Three Instructional Segment 4: Weather Impacts, p. 238

**Key Area 2: Life Science**

For extended vignettes on children's explorations of plants, refer to the following:

*California Preschool Curriculum Framework, Volume 3* (Additional resources from the *Preschool Curriculum Frameworks* should be used alongside the current *Preschool/Transitional Kindergarten Learning Foundations*)

- Record and Document, Vignette, p. 166
- Vignette, p. 206

*Science Framework for California Public Schools*

- Kindergarten Instructional Segment 1: Plant and Animal Needs, p. 109
- Grade One Instructional Segment 1: Plant Shapes, p. 140
- Grade Two Instructional Segment 4: Biodiversity in Landscapes, p. 178

**Key Area 3: Physical Science**

For extended vignettes on children's explorations of force and motion, refer to the following:

*California Preschool Curriculum Framework, Volume 3* (Additional resources from the *Preschool Curriculum Frameworks* should be used alongside the current *Preschool/Transitional Kindergarten Learning Foundations*)

- Vignette, p. 147
- Vignette, p. 187
- Bringing It All Together, Rolling Objects, p. 193

*Science Framework for California Public Schools*

- Kindergarten Instructional Segment 4: Pushes and Pulls, p. 130
- Grade Three Instructional Segment 1: Playground Forces, p. 20

**Key Area 4: Earth and Space Science**

For extended vignettes on children's explorations of landscapes and earth materials, refer to the following:

*California Preschool Curriculum Framework, Volume 3* (Additional resources from the *Preschool Curriculum Frameworks* should be used alongside the current *Preschool/Transitional Kindergarten Learning Foundations*)

- Vignette, p. 216
- Vignette, p. 217
- Vignette, p. 220

*Science Framework for California Public Schools*

- Grade Two Instructional Segment 1: Landscape Shapes, p. 163
- Grade Two Instructional Segment 2: Landscape Materials, p. 169
- Grade Two Instructional Segment 3: Landscape Changes, p. 173

**Key Area 5: Engineering, Technology, and Applications of Science**

For extended vignettes and ideas for how children might engage in engineering design, refer to the following:

*Science Framework for California Public Schools*

- Kindergarten Instructional Segment 1: Plant and Animal Needs, Engineering Connection—Reduce, Reuse, Recycle, p. 118
- Kindergarten Instructional Segment 1: Plant and Animal Needs, Vignette 3.1—Made for the Shade, p. 125
- Kindergarten Instructional Segment 4: Pushes and Pulls, Engineering Design Challenge—Save a Structure, p. 138
- Grade One Instructional Segment 1: Plant Shapes, Engineering Connection—Using Bio-Mimicking to Solve a Problem, p. 143
- Grade One Instructional Segment 2: Animal Sounds, "Sounds Wild" Engineering Challenge, p. 149
- Grade Two Instructional Segment 2: Landscape Materials, Engineering Connection—Create a Better Soil, Create a New Toy with Old Parts, p. 173
- Grade Two Instructional Segment 3: Landscape Changes, Engineering Connection—Design a Way to Slow or Stop Changes to the Landscape, p. 176
- Grade Two Instructional Segment 4: Biodiversity in Landscapes, Engineering Connection—Design a Seed, p. 186
- Grade Three Instructional Segment 1: Playground Forces, Engineering Connection—Designing a Better Swing, p. 218
- Grade Three Instructional Segment 3: Surviving in Different Environments, Engineering Connection—Minimizing the Effects of a Levy Break on the Environment

# Endnotes

1 California Department of Education, *Preschool/Transitional Kindergarten Learning Foundations: Science* (Sacramento: California Department of Education, 2024).

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

3 Christine M. McWayne, Jayanthi Mistry, Sunah Hyun, Virginia Diez, Cynthia Parker, Betty Zan, Daryl Greenfield, and Kimberly Brenneman, "Incorporating Knowledge from Children's Homes and Community: A Home-to-School Approach for Teaching STEM in Preschool," *Young Children* 75, no. 5 (December 2020): 20–27.

4 Daryl B. Greenfield, Alexandra 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; 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).

5 California Department of Education, *Science Framework for California Public Schools: Kindergarten Through Grade Twelve* (Sacramento: California Department of Education, 2016); Douglas H. Clements and Julie Sarama, "Math, Science, and Technology in the Early Grades," *The Future of Children* 26, no. 2 (Fall 2016): 75–94; National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades*.

6 National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades*.

7 National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades*.

8 California Department of Education, *Science Framework for California Public Schools*.

9 California Department of Education, *California's Great Start Transition to Elementary School Toolkit: Supporting a Smooth and Effective Transition to Transitional Kindergarten, Kindergarten, and First Grade* (Sacramento: California Department of Education, 2023); California Department of Education, *The Powerful Role of Play in Early Education* (Sacramento: California Department of Education, 2021).

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

11 Greenfield, Alexander, and Frechette, “Unleashing the Power of Science in Early Childhood”; National Academies of Sciences, Engineering, and Medicine, *Science and Engineering in Preschool Through Elementary Grades*.

12 California Department of Education, *Science Framework for California Public Schools*.

# Bibliography

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

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

California Department of Education. 2016. *Science Framework for California Public Schools: Kindergarten Through Grade Twelve*. Sacramento: California Department of Education.

California Department of Education. 2021. *The Powerful Role of Play in Early Education*. Sacramento: California Department of Education.

California Department of Education. 2023. *California's Great Start Transition to Elementary School Toolkit: Supporting a Smooth and Effective Transition to Transitional Kindergarten, Kindergarten, and First Grade*. Sacramento: California Department of Education.

California Department of Education. 2024. *Preschool/Transitional Kindergarten Learning Foundations: Science*. Sacramento: California Department of Education.

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

Greenfield, Daryl B., Alexandra 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.

McWayne, Christine M., Jayanthi Mistry, Sunah Hyun, Virginia Diez, Cynthia Parker, Betty Zan, Daryl Greenfield, and Kimberly Brenneman. 2020. "Incorporating Knowledge from Children's Homes and Community: A Home-to-School Approach for Teaching STEM in Preschool." *Young Children* 75 (5): 20–27.

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