INTRODUCTION

Uncovering the body of scientific knowledge, the development of the vast array of designed products, and the associated intellectual activities are the work of scientists and engineers. Students, in their pursuit of core scientific knowledge, engage in similar work. The intellectual activities (science and engineering practices) represent one dimension of the Next Generation Science Standards (NGSS). Some of these practices are innately natural for students as they observe and tinker with the world around them. Others may be alien at first, but with support and guidance from teachers, will become part of the way students think and work in science.

Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science. Participation in these practices also helps students form an understanding of the crosscutting concepts and disciplinary ideas of science and engineering; moreover, it makes students’ knowledge more meaningful and embeds it more deeply into their worldview.

The actual doing of science or engineering can also pique students’ curiosity, capture their interest, and motivate their continued study (A Framework for K–12 Science Education, 2012, page 42).
Science and Engineering Practices—Grade 1

There are eight practices described in A Framework for K–12 Science Education. The practices are the same for K–2, but the capabilities form a learning progression described in grade bands—K–2, 3–5, 6–8, and 9–12. Below are the capabilities for the grades K–2 grade band. Those in bold are emphasized in first grade based on the NGSS performance expectations.

1. **Asking questions and defining problems**
   - Ask questions based on observations to find more information about the natural and/or designed world(s).
   - Ask and/or identify questions that can be answered by an investigation.
   - Define a simple problem that can be solved through the development of a new or improved object or tool.

2. **Developing and using models**
   - Distinguish between a model and the actual object, process, and/or events the model represents.
   - Compare models to identify common features and differences.
   - Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).
   - Develop a simple model based on evidence to represent a proposed object or tool.

3. **Planning and carrying out investigations**
   - With guidance, plan and conduct an investigation in collaboration with peers (for K).
   - Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
   - Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
   - Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
   - 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.
   - Make predictions based on prior experiences.
4. **Analyzing and interpreting data**
   - Record information (observations, thoughts, and ideas).
   - Use and share pictures, drawings, and/or writings of observations.
   - 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.
   - Compare predictions (based on prior experiences) to what occurred (observable events).
   - Analyze data from tests of an object or tool to determine if it works as intended.

5. **Using mathematics and computational thinking**
   - Decide when to use qualitative vs. quantitative data.
   - Use counting and numbers to identify and describe patterns in the natural and designed world(s).
   - Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
   - Use quantitative data to compare two alternative solutions to a problem.

6. **Constructing explanations and designing solutions**
   - Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.
   - Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.
   - Generate and/or compare multiple solutions to a problem.

7. **Engaging in argument from evidence**
   - Identify arguments that are supported by evidence.
   - Distinguish between explanations that account for all gathered evidence and those that do not.
   - Analyze why some evidence is relevant to a scientific question and some is not.
   - Distinguish between opinions and evidence in one’s own explanations.
Science and Engineering Practices—Grade 1

- Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.
- Construct an argument with evidence to support a claim.
- Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.

8. Obtaining, evaluating, and communicating information
- Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).
- Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.
- Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.
- 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.

While these are presented in this order, the Framework issues a word of caution.

In doing science or engineering, the practices are used iteratively and in combination; they should not be seen as a linear sequence of steps to be taken in the order presented (A Framework for K–12 Science Education, 2012, page 49).

Science and Engineering Practices in FOSS Investigations

One goal of the FOSS Program is scientific literacy for all students. This means more than just knowledge of core ideas. Scientific literacy includes engaging in the activities and intellectual behaviors of scientists and engineers. Written into each investigation are specific steps that aim to build student competence with each practice. Over the course of the year, the expectation is for all students to have multiple experiences with the practices. Student capabilities with each practice should advance as the year progresses. Teachers will need to purposefully plan instructional opportunities in order to advance these capabilities.
Throughout the *Investigations Guide* you will see specific practices called out in the sidebar next to a step. The table “Science and Engineering Practices Opportunities in FOSS” at the end of this chapter is the complete list. In some cases, you will also see a Teaching Note (see sidebar) instructing you to look at a specific section of this chapter to engage students in that practice. These grade-level examples for practices that are described in this chapter are shown in the table below.

For example, a strategy called “put in your two cents” can be used for developing an argument to determine whether or not worms are good for soil. In other cases, the teacher will need to decide how best to advance student capabilities throughout the year. This can be through a series of questions and frames or through mini-lessons suggested in this chapter. Prior experiences, amount of time, and complexity of the investigation factor into these decisions. At times, a deep dive into constructing explanations is a reasonable endeavor, other times, introducing a data collection tool is appropriate. The driving idea is for teachers to make purposeful decisions about when and how to engage students so their skills within each practice grow over the year.

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Grade-level examples for practices described in this chapter.
Supporting Student Engagement with Practices

In order to support students with the practices, teachers will want to utilize a combination of instructional strategies. Listed below are general strategies that can be used for any practice. Strategies for specific science and engineering practices are shared in the following sections.

**Questions, frames, and prompts.** Questions can focus student attention on a specific practice. Ideally, these questions should probe for students to communicate their thinking about one practice at a time to maintain focus. The teacher can provide frames and prompts for students to communicate and organize their thinking. Specific questions, frames, and prompts are provided for each practice in the corresponding sections.

**Teacher think-aloud.** The teacher can model the path an expert takes with a specific practice by verbalizing or modeling the thinking process. This is especially important for younger students they are just starting to work with the practices. For example, “When I think about planning an investigation, I think about which step I should take first and write that down or draw a picture of what I am doing. Next, I need to ______.” Or use statements, such as “What Roy just said makes me think I should try to find one more piece of evidence. I should include more evidence to make my argument stronger.” Modeling shows students what the expectations are, and helps them understand the structure and scope of each practice.

**Critique teacher-generated examples.** The teacher can provide a partially developed example or use of the practice, such as a procedure that is out of order or a drawing of a plant that is missing leaves.
WORKING WITH PRACTICES

Asking Questions (Science) and Defining Problems (Engineering)

Asking questions is essential to developing scientific habits of mind. Even for individuals who do not become scientists or engineers, the ability to ask well-defined questions is an important component of science literacy, helping to make them critical consumers of scientific knowledge (A Framework for K–12 Science Education, 2012, page 54).

As students engage with phenomenon through active investigation, they should begin to ask questions. First grade students ask lots of questions when they work with new materials. These initial questions may not be questions that will lead to uncovering essential truths about the natural world and often need to be refined. Student actions as they work with materials are usually cause-and-effect questions, such as “What happens when I push the plunger down?” Students might need guidance to connect these actions with questions that can be investigated. For example, when students are testing compressed air, the teacher might say, “It looks like you pushing the plunger down on one syringes and seeing what happens. You are trying to find out what happens when you compress air.” Other questions, such as “Why is the feather red?” are not ones students can answer through investigation. Students should engage with probing questions to come to understand the nature of meaningful questions; the systematic process of seeking and acquiring answers. Additionally, new questions should arise as a result of observing during investigations, continuing the process. Questions about phenomena, such as air being compressed, will increase in complexity as student knowledge of a subject increases.

When students begin to confront engineering challenges, they need to define the problem they need to solve. As they design, construct, test, and redesign, they often might have new problems they need to solve. Defining both the overarching problem as well as those problems that arise along the pathway toward a solution are important for students to recognize and communicate during their work.

Working with students asking questions and defining problems.

Asking questions and defining problems can occur at any time. In the Investigations Guide there are specific steps where teachers can probe for student questions. These should not be viewed as the only opportunities for students to ask questions.

A big step in a teacher’s practice is the ability to recognize student questions about their learning and help them clarify questions about their own understanding. It is not the teacher’s job to answer all of

Appendix F of NGSS identifies student capabilities as they ask questions and define problems. The one in bold appears in the performance expectations for engineering for grades grade K-2.

- Ask questions based on observations to find more information about the natural and/or designed world(s).
- Ask and/or identify questions that can be answered by an investigation.
- Define a simple problem that can be solved through the development of a new or improved object or tool.
those questions. First graders have had some experience with asking questions but still need guidance in asking answerable questions. When students ask questions, the teacher sorts those questions (in their head) into four categories and then takes appropriate action.

1. **Questions that are reasonable for students to investigate, even if they need some refining.** Suggestions for helping students reword or focus these questions are provided below.

2. **Questions that can be answered by information acquisition through readings, or other sources.** For suggestions to help students obtain information through other sources, see the section in this chapter on obtaining, evaluating, and communicating information.

3. **Questions that can be answered by thinking and analysis of available information during a sense-making discussion.** Suggestions for working with questions can be found in the Sense-Making Discussions for Three-Dimensional Learning.

4. **Questions that are fanciful or developmentally out of the cognitive range of students.** For the latter, teachers should aim to keep the curiosity of students intact but not feel compelled to pursue the question. A simple, “So you are wondering <student’s question>. I’m curious about that too,” works reasonably well.

**Example in Grade 1**

Ask questions based on observations to find more information about the natural and/or designed world(s). In the **Air and Weather Module**, Investigation 4, Part 2, students are introduced to a bar graph containing the number of daylight hours during the months of the year. They are tasked with generating questions they could answer if they graphed more data. In this example, the teacher wants to support students in asking questions as this is her first module in the year. The teacher uses an instructional strategy to help students ask questions about their observations. The teacher models a question by doing a think-aloud. For example, “I know it gets dark around dinner time in the winter. I wonder, ‘Do all seasons have different amounts of daylight?’” After recording this question on the board or in a class notebook, students can share something they notice or wonder. The teacher rephrases their statements as questions they could answer. When students are asked to develop questions again in another module, she revisits these questions about the graphs and uses those as a springboard for new questions. The teacher can provide guidance such as, “I wonder if we can ask a question that is similar to _____.” Encourage students.
to ask their own questions and over time you will see improvement in the quality of the questions.

**Additional strategies for asking questions and defining problems.**

**Ask and/or identify questions that can be answered by an investigation.** Generate a list of questions with students after a common experience with a phenomenon. These questions should be written on the board or on sentence strips. Questions should be ones that students could answer using materials and some that they cannot. For example, in the Plants and Animals Module, students might ask, “What do you think might happen in the next week or two?” and “Why does that group’s cutting have more leaves than ours?” Have a discussion about what would have to be done to answer those questions. Guide students to sorting the questions into “Ones we could answer” and “ones we can’t answer.” As time permits, allow students to investigate some of the questions.

As students progress through the year, take one of the questions in the “ones we can’t answer” group and model how to rephrase the question. For example, “Why does that group’s cutting have more leaves than ours?” could be, “Do all cuttings have different numbers of leaves?” Students can work on rephrasing other questions in the group. Towards the end of the year, record a number of questions and have students sort them. Ask them how they could change part of the question to make it one they can investigate.

**Define a simple problem that can be solved through the development of a new or improved object or tool.** As students engage with phenomena, they may have shared engineering experiences, and opportunities to identify problems, both in and beyond the classroom. When introducing the design problem, such as building a device to communicate around a corner have students turn and restate the problem in their own words with a partner. These problems can be recorded on a piece of chart paper throughout design process. As the year progresses and students begin to develop their own engineering problems to solve, similar strategies to those shared above can be used.

**Sentence frames for students to use to ask questions and define problems.**

- What does _____?
- Where is _____?
- When I _____ why does _____?
- When does _____?

Here are other examples of asking questions and defining problems in FOSS grade 1 modules.

- In the Air and Weather Module, students ask questions about rocks and soil they find in the school yard.
- In the Sound and Light Module, students define a simple problem that can be answered by making a better parachute.
- In the Plants and Animals Module, students ask questions about the adopted plants.
• Why is _____?
• Why does _____?
• I predict _____.
• I wonder _____.
• What would happen if _____?
• What causes _____?
• What is the effect of _____?
• How does _____ affect _____?
• What would change if _____?
• I predict _____ because _____.
• The problem we will solve is _____.

Questions for teachers to ask students about asking questions and defining problems.
• Which of these questions are you wondering about?
• Which of these parts do you want to change?
• Could _____ be the problem you might solve?
• What questions do you have about _____?
• What questions do you have about what you might change?
• What questions could you ask to find out _____?
• What is the problem we are trying to solve?
• How might we solve this problem?
• What do you need to know about _____?
Developing and Using Models

Scientists use models (from here on, for the sake of simplicity, we use the term “models” to refer to conceptual models rather than mental models) to represent their current understanding of a system (or parts of a system) under study, to aid in the development of questions and explanations, and to communicate ideas to others … Models can be evaluated and refined through an iterative cycle of comparing their predictions with the real world and then adjusting them, thereby potentially yielding insights into the phenomenon being modeled. (A Framework for K–12 Science Education, 2012, page 13.)

As students explore phenomena, systems, and the world around them, they formulate models about phenomena and how and why things work the way they do. These models, either emerging or fully developed, guide questions and explanations about the working of the natural world. Students represent their models and use them to communicate and test their ideas about cause-and-effect relationships.

Working with students developing and using models.

The Investigations Guide identifies steps in which students can develop and use models. Initially, students formulate primitive models to explain phenomena and how the world works with naive intuitive thinking. Their models will often be drawings with some thinking attached to them. The teacher can ask questions or provided experiences to guide further development of the model. Depending on the timing, questions might be asked when the teacher is listening to a small group. Questions such as, “How does that work?” and “What would happen if you added a second cup and string to the spoon gong?” will prompt students to improve their model. During a sense-making discussion, the teacher can have students share their models with others, providing a way to get feedback and think critically about how to make adjustments. As the year progresses, the teacher scaffolds the development of students own models based on data.

Example in Grade 1

Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). In the Plants and Animals Module, Investigation 3, Part 2, students have observed terrariums with plants. Students make drawings of the terrarium. The teacher identifies these drawings as a model that shows what they are finding out about the terrariums. Models show thinking, in this case, through a drawing. The class determines how to label the various parts of the terrarium and consider how to show the plant growth using Appendix F of NGSS identifies student capabilities as they develop and use models. The one in bold appears in the performance expectations for engineering for grades K-2.

• Distinguish between a model and the actual object, process, and/or events the model represents.
• Compare models to identify common features and differences.
• Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).
• Develop a simple model based on evidence to represent a proposed object or tool.
arrows. Students use these model to compare changes between day 1 and day 5 of plant growth.

**Additional strategies for developing and using models.**

**Distinguish between a model and the actual object, process, and/or events the model represents.** The teacher can support students in comparing during a discussion by asking student questions about the difference between a model and the real object. Initial questions to students can be about the difference in size or other visual differences. Images from *Science Resources* can provide visuals for students as well. Beyond the size, students might mention that some models do not do the same thing as the real thing. For example, the demonstration thermometer doesn’t change like real thermometers do. When students are comparing a model to an actual object or process, provide structured opportunities for students to focus on one aspect or step. As they progress, see if students can identify similarities and differences more independently.

**Compare models to identify common features and differences.** Ideally, young students should work directly with actual objects or processes. During the Wrap-Up/Warm-Up students frequently share their models with others. Before having students share their notebooks, ask them to find one thing both partners’ models have that is the same and one thing that is different. After sharing with their partner, call on pairs to identify those common features first. Students should identify aspects of their models that help them understand or show what they are studying. Differences often are found in how students represent parts of their model. For example, one student might use squiggly lines to show vibrations while another uses a few parenthesis. Both show vibrations, but in different ways. To further support students when comparing models, ask students to generate words, such as *smaller* or *larger* that can be used to identify difference.

**Develop a simple model based on evidence to represent a proposed object or tool.** When developing a model of a tool or object, the teacher needs to carefully guide students through the process initially. For example, students are challenged to create a device to communicate back and forth in the *Sound and Light Module*. This can begin by guiding a discussion about what they observed when working with the spoon gong. Students identify the sound source. Show students one of the available materials and ask guiding questions, such as, “Do you think this material might be used as the sound source?” Continue the discussion by doing think-alouds as you hold up one object at a time. “I wonder what this might be used for.” Have students turn and talk about how they could use a particular material.
Providing this guidance focuses students’ designs. Allow students to visit with others and get ideas to try in their model. As the year progresses, continue to review what observations students have made that aid the design process. Present students with a few of the materials they can use at a time rather than one at a time.

**Sentence frames for students to use to develop and use models.**

- The model shows _____.
- The model doesn’t show _____.
- The parts of my model are _____.
- This model is different because _____.
- My model shows how _____ changes _____.
- I changed my model because _____.

**Questions for teachers to ask students about developing and using models.**

- How can you make a drawing in your notebook to explain _____?
- What could you add to your model to show _____?
- Does this part mean _____?
- What ideas could you add to your model?
- What changes could you make?

Here are other examples of developing and using models in FOSS grade 1 modules:

- In the **Air and Weather Module**, students develop models about how parachutes work.
- In the **Sound and Light Module**, students develop and use models to show how light is redirected using mirrors.
- In the **Plants and Animals Module**, students use a terrarium as a model to study plant growth.
Appendix F of NGSS identifies student capabilities as they plan and carry out investigations. Those in bold appear in the performance expectations for grade 1.

- With guidance, plan and conduct an investigation in collaboration with peers (for K).
- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
- Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
- Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
- 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.
- Make predictions based on prior experiences.

**TEACHING NOTE**

See the Air and Weather Module, Investigation 2, Part 2, Steps 15–17 for the context related to this example. This is a location that we identified in the Investigations Guide as a good opportunity to develop the practice of planning and carrying out investigations.

### Planning and Carrying out Investigations

Scientists and engineers investigate and observe the world with essentially two goals: (1) to systematically describe the world and (2) to develop and test theories and explanations of how the world works. In the first, careful observation and description often lead to identification of features that need to be explained or questions that need to be explored (A Framework for K–12 Science Education, page 59).

Students plan and carry out investigations in pursuit of data to be analyzed. Investigations can be conducted under teacher guidance in order to gain experience with controlling variables, using tools such as balances or thermometers, and making sufficient observations. Students can contribute to a common class or group investigation in which materials and procedures are identified. Predictions can be made based on observations and analysis of cause-and-effect relationships.

**Working with students planning and carrying out investigations.**

Much like other practices, students in first grade will need guidance in carrying out investigations. These experiences will serve as a starting point for students. When investigating phenomena, a teacher needs to consider the allocation of time, the level at which students can plan and conduct, and what skills students can develop during the lesson. In the Investigations Guide, procedures might be provided for everyone to follow for the first time. Later in the module, students might develop procedures collaboratively with the teachers’ guidance. Teachers will need to adjust their expectations to the skill and experiences of their students. Similarly, instructions on how to use tools accurately will be introduced during an early investigation and the teacher will need to monitor the use of the tool throughout the year.

The data collected while carrying out investigations is often recorded on a provided notebook sheet or students can develop their own recording method with teacher support. Again, the teacher needs to determine the time available and the prior experience of students.

**Example in Grade 1**

Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. In the Air and Weather Module, Investigation 2, Part 2, Steps 15–17, students are asked to plan how to determine what time of day is the air the warmest. For a guided approach, the teacher asks students for ideas. Students typically identify using a thermometer to measure the temperature but might not think to measure the temperature in the same spot or at multiple times of the day. The teacher can provide a nonexample of a procedure to prompt students to be more detailed in...
their planning. For example, the teacher might say, “I was thinking of going out in the morning and measuring the temperature under the tree and then in the afternoon I would go to the playground.” Students are quick to identify the need to go to the same place and think about how often to measure. In this example, students are prompted to think about the variables by critiquing the nonexample.

In the Plants and Animals Module, students are planting four plants in a terrarium. The procedure involves following several steps and using a map to determine the location. In the beginning of the year, this can be done by modeling one step at a time while the students replicate it in their own terrarium. If doing this towards the end of the year, the teacher might show all the steps prior to releasing the student to setup their own.

Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. In the Sound and Light Module students work with a xylophone to determine how to produce loud and soft sounds. Students make observations and compare what was done to produce the different volumes. The teacher guides the reporting of these observations. Through these comparisons they determine to make a loud sound, you hit the xylophone hard. For a soft sound, you hit the xylophone gently.

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. Later in the Sound and Light Module students are presented with an engineering challenge, they need to shine a light on a book with the flashlight facing the other direction. Ask students questions related directly to the challenge throughout the design process, such as “What does the light need to do to change directions?” and “How can you use the mirror to redirect light?” As the year progresses, questions become, “What are you trying to do with the light?” and “What did you observe that makes you think you solved your problem?” This allows students to connect their observation to the criteria of the challenge.

Many investigations in FOSS have indicated steps for students to use to produce data. Some of these have prepared notebook sheets with a data collection tool. These can serve as resources for students to reference when developing their own methods. Students can record their observations in the class notebook to serve as models for other students. As the year progresses, guidance is still provided for new procedures and ways to make observations, however, scaffolds are gradually removed as skills increase.

Science and Engineering Practices—Grade 1
**Science and Engineering Practices—Grade 1**

**Additional strategies for planning and carrying out investigations.**

Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question. Time and effort for students to record data is at a premium in first grade. In order to best evaluate different ways to observe a phenomenon, students need experience in different methods. Guide students in making quality observations by asking questions such as, “Would it be better to look at the terrarium from the side or from the top to see all of the parts? How could we record these different points of view in our notebook?”

**Make predictions based on prior experiences.** Making predictions in first grade, as well as other grades, needs to be based on prior experience. In many cases, the Investigation Guide provides prompts for students to make predictions at the appropriate time. A good way to help students make predictions is to generate a list of possible outcomes first by asking, “What could happen when we <change you are making>?”. This allows students to consider all the possible outcomes before firming up which one they believe will happen. A general rule, if students cannot think of possible outcomes or make reasonable predictions, they need more experience or have not yet discovered a pattern in the data. In these cases, provide the experience rather than waiting for predictions and revisit it later.

When you do hear students excitedly make predictions in the spur of the moment, seize the opportunity and ask them, “Why do you think that will happen? What have you observed before that makes you think that?” These questions connect predictions to observed patterns.

**Sentence frames for students to use to plan and carry out investigations.**

- First, we will _____.
- Next, we will _____.
- Then, we will _____.
- If we change _____, then _____.
- I predict _____ because _____.
- I observe _____.
- I want to find out ____.
- We could _____ to see if ____.

Here are other examples of planning and carrying out investigations in FOSS grade 1 modules.

- In the **Air and Weather Module**, students make observations about the weather over time.
- In the **Sound and Light Module**, students plan and carry out investigations with light shining on different materials.
- In the **Plants and Animals Module**, students plan and carry out investigations and observe how parts of plants can be planted to grow new plants.
Questions for teachers to ask students about planning and carrying out investigations.

• Are you trying to find out _____?
• Have you thought about _____?
• What will you do first? Second?
• Will you need _____?
• Does _____ meet the criteria?
• What are you trying to find out?
• How could you find out _____?
• Is there another way?
• What materials will you need?
• How will you test _____?
• Is there anything else you want to find out?
Analyzing and Interpreting Data

At the elementary level, students need support to recognize the need to record observations—whether in drawings, words, or numbers—and to share them with others. As they engage in scientific inquiry more deeply, they should begin to collect categorical or numerical data for presentation in forms that facilitate interpretation, such as tables and graphs (A Framework for K–12 Science Education, 2012, page 63).

Once data have been collected, they must be organized for interpretation and analysis. Students initially need guidance on how to organize and display numerical data in tables or graphs. Narrative observations also need to be organized in logical ways so students can analyze them. Through teacher guidance, students should strive to discover patterns in their data. In engineering, this analysis can help determine if design changes resulted in the desired effect.

Working with students analyzing and interpreting data

As students carry out investigations, they collect data in various forms. Students need to learn how those data can be organized for analysis.

In the Investigations Guide, suggestions are made for data collection tools. Some might require a mini-lesson; others might be accomplished through questioning and discussion. The Science Notebook in Grades K–2 chapter discusses strategies for guiding students’ use of organizing tools, such as tables, graphs, and drawings.

When data are organized, teachers need to help students analyze and interpret data. This can often be done effectively during sense-making discussions. In a sense-making discussion, the teacher poses questions to guide students to uncover patterns and relationships. See the Sense-Making Discussions for Three-Dimensional Learning chapter for more information on how to conduct this type of discussion with students.

Example from Grade 1

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.

In the Air and Weather Module, Investigation 3, Part 2, Step 11 is the context related to these examples. This is a location that we identified in the Investigations Guide as a good opportunity to develop the practice of analyzing and interpreting data.
they make their observations. As the year progresses and students have had several experiences making detailed drawings and analyzing data during discussions, they should be given more independence in making those connections. Teachers should monitor and make the necessary adjustments to guide students. This can be done by having students revisit previous notebook entries. The Investigations Guide and the Sense-Making Discussions for Three-Dimensional Learning chapter contain information about questions to ask and how to scaffold these discussions over the course of the year. Some investigations allow students to focus on the cause-and-effect relationships and others focus on patterns. Strategies for working with these are also shared in the Crosscutting Concepts for Grade 1 chapter.

**Other strategies for analyzing and interpreting data.**

**Analyze data from tests of an object or tool to determine if it works as intended.** During the sense-making discussion, students may share their data about the testing of a designed object, such as a parachute. The teacher can ask questions to guide the discussion such as, “The purpose of a parachute is to slow down a fall to make a soft landing. Looking at your landing, what does that tell you about your parachute?” In general, some first graders will need guidance on comparing the results of using the tool or object to the established criteria.

**Record information (observations, thoughts, and ideas) and use and share pictures, drawings, and/or writings of observations.** The Investigations Guide provides recommendations for when students should record information for further analysis during the sense-making discussion. The Science Notebooks for Grades K-2 chapter shares specific strategies for ways students can record, use and share their observations over the course of the year.

**Compare predictions (based on prior experiences) to what occurred (observable events).** As indicated in the planning and conducting investigation section, students make predictions about what might happen when a change is made. Be sensitive when asking students to compare their predictions to what occurred. Students might interpret their predictions as wrong or even go as far as trying to erase their original predictions. Focus the attention on why they made the prediction rather than if it is right or wrong. A safe way to do that is to say something like, “I really thought that I wouldn’t see the Moon during the day. That made sense to me at that time. Now that I have seen this, I wonder why we can see the Moon during the day.” In this example, the teacher took ownership of a prediction that was reasonable (and likely similar to many students) and used it as an opportunity to ask a question. A scientist or engineer might say, “Hmmm, that’s strange, I wonder why that happened.”

*Here are other examples of analyzing and interpreting data in FOSS grade 1 modules.*

- In the **Air and Weather Module**, students analyze and interpret data about clouds.
- In the **Sound and Light Module**, students analyze and interpret data about what is needed to see.
- In the **Plants and Animals Module**, students analyze and interpret data about what happens when grass is mowed.

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*Science and Engineering Practices—Grade 1*
Science and Engineering Practices—Grade 1

Sentence frames for students to use to analyze and interpret data.

- I observe _____.
- It looks _____.
- It feels _____.
- It smells _____.
- It sounds like _____.
- I think _____.
- _____ reminds me of _____.
- My picture shows _____.

Questions for teachers to ask students about analyzing and interpreting data.

- Is this a pattern?
- Are these the same or different?
- Do you think it means_____?
- How could you start your drawing _____?
- Does this mean your design works?
- What do you observe?
- What surprised you?
- Does this change what you think about _____?
- What patterns do you observe?
Using Mathematics and Computational Thinking

Mathematics and computational tools are central to science and engineering. Mathematics enables the numerical representation of variables, the symbolic representation of relationships between physical entities, and the prediction of outcomes. Mathematics provides powerful models for describing and predicting … (A Framework for K–12 Science Education, 2012, page 64).

Strongly connected to planning and carrying out investigation and interpreting and analyzing data, mathematics plays heavily into the work of science and engineering. Measurements and other quantitative data can be collected and organized in various arrays for analysis. These data can be used to support student models, explanations, and design solutions.

Working with students using mathematics and computational thinking.

Students need to understand the difference between qualitative and quantitative data and know when to use them. This requires guidance and discussion. Asking questions, such as, “Is this something we should describe using numbers or words?” are useful for students to consider. Quantitative data (things counted or measured) can be displayed in various ways for analysis. In first grade, students are familiar with numbers, words, and simple graphs. They will still need support in developing these graphs. The work they do in K–2 serves as foundational skills for later grades when the capabilities (see the list in the sidebar) are further developed.

Strategies for using mathematics and computational thinking.

Most collection methods in first grade for both quantitative and qualitative are provided for students. When introducing these, have a quick discussion about why students are using numbers or words. Use a think-aloud, such as, “I am going to compare the length of the roots and compare that to the length of the leaves” In the Investigations Guide, mini-lessons on how to make graphs are included when relevant.

Appendix F of NGSS identifies student capabilities as they use mathematics and computational thinking. None of these appear in the performance expectations for grade 1.

- Decide when to use qualitative vs. quantitative data.
- Use counting and numbers to identify and describe patterns in the natural and designed world(s).
- Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
- Use quantitative data to compare two alternative solutions to a problem.
Science and Engineering Practices—Grade 1

Sentence frames for students to use for mathematics and computational thinking.

- We counted _____.
- There are more/less _____.
- The _____ is bigger/smaller _____.
- We found out that _____.
- The graph/table shows _____.

Questions for teachers to ask students about using mathematics and computational thinking.

- How many?
- How much?
- How long?
- How could you find out how many?
- How could you find out how long?

Here are examples of using mathematics and computational thinking in FOSS grade 1 modules.

- In the **Air and Weather Module**, students use mathematics and computational thinking to compare the weather data from different seasons.
- In the **Plants and Animals Module**, students use mathematics and computational thinking to compare the amount of red and grey squirrels.
Constructing Explanations and Designing Solutions

Engaging students with standard scientific explanations of the world—helping them to gain an understanding of the major ideas that science has developed—is a central aspect of science education. Asking students to demonstrate their own understanding of the implications of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed, engages them in an essential part of the process by which conceptual change can occur. Explanations in science are a natural for such pedagogical uses, given their inherent appeals to simplicity, analogy, and empirical data (which may even be in the form of a thought experiment). And explanations are especially valuable for the classroom because of, rather than in spite of, the fact that there often are competing explanations offered for the same phenomenon—for example, the recent gradual rise in the mean surface temperature on Earth (A Framework for K–12 Science Education, 2012, page 68).

When students have analyzed data, they extract meaning and transfer that meaning to explain other observable phenomena and answer questions. These explanations, (in engineering—solutions), are based on data and/or models. Many questions are related to phenomena are such as, “What is the effect of wind on pinwheels?” When explaining the phenomenon of a cause-and-effect relationship, students should use observations. Claims, evidence, and reasoning are developed in upper elementary and middle school where there are opportunities for students to reason sufficiently during a sense-making discussion.

Students utilize their scientific understanding to develop solutions to problems. Once solutions are developed, students carefully analyze data to determine whether the proposed solutions do or do not meet the established criteria and honor the constraints.

Working with students constructing explanations and designing solutions.

As students analyze and interpret data during sense-making discussions, they construct thoughts about phenomena, respond to questions, and design and evaluate solutions to problems. Teachers should guide students to communicate explanations with others, use sentences frames, and allow time for revision. During discussions, teachers should listen for explanations and use clarifying questions based on student responses. At the beginning, teachers might have students develop a claim as a class and model how to use data as evidence to support their claim. As the year progresses, students develop their claims and select data to use as evidence independently. When appropriate, the teacher can push for model-based reasoning, or the “why <student claim> is happening.”

Appendix F of NGSS identifies student capabilities as they construct explanations and design solutions. Those in bold appear in the performance expectations for grade 1.

- **Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.**
- **Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.**
- **Generate and/or compare multiple solutions to a problem.**
When expressing their reasoning, teachers should encourage students to use relevant academic vocabulary and take ample time for this to be developed in discourse with peers.

In the *Investigations Guide*, specific focus questions guide each part. These questions call for students to construct an answer to the questions at the end of the part. While the focus questions pertain to one part, a guiding question is broader. Students construct explanations for the guiding questions for the investigation as well. These broader explanations connect to the Disciplinary Core Ideas and the natural or designed world.

**Example in Grade 1**

Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena and use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. In the *Sound and Light Module*, Investigation 1, Part 2, students observe rice on a lid placed just above a moving speaker. Students have felt the speaker move and heard the sound produced. Through questioning, students construct an explanation on how the vibrations are traveling through the air and making the lid and rice vibrate. Investigation 3, Part 1, students use a set of solid objects and a flashlight to observe shadows. They observe the shape of shadows, what happens when you move the flashlight or change the orientation of the object. In making these observations, students determine what makes a shadow. In the beginning of the year, students need a high level of scaffolding as they construct explanations. Students can discuss questions, “How are the shadows different?” and “How were they the same?” as a class. The class can answer the focus question together in the class notebook. As students progress through the year in both their writing ability and their skill in constructing explanations, the class notebook can be used to model a portion of constructing an explanation.

In the *Plants and Animals Module*, Investigation 4, Part 2, students have observed carrot and radish planters. These observations are used to explain what parts of the parent plant can grow new plants. Similarly to observing shadows, students discuss their observations and are questioned to explain their thinking about the focus question. A sentence frame such as, “I think ____ . My evidence is ____ .” can be modeled in the class notebook.
In the **Air and Weather Module**, students construct a parachute and observe how it falls to Earth when released. These observations are shared and discussed. Students use these observations to explain how the parachute interacts with air. The sentence frame, “The parachute did that because _____.” prompts students to create a model to explain how the air pushes up on the parachute to slow the fall.

In Investigation 4, Part 4 of the **Sound and Light Module**, students use their understanding of light and mirrors to design a solution to communicate with another group around a corner. The teacher asks questions to guide the design process. The teacher might use the sentence frame, “To get the light to go around the corner, we ____.” Students can answer the question orally in the discussion and when they use their own science notebook, they can access the words such as *redirect* on the word wall. To support students even further, the teacher can design their own solution to the challenge and model how to share that design with others.

As students understand scientific ideas, they have the opportunities to transfer and apply those ideas to the designed world. As students begin to work on a particular problem, some might see the relationship between a design and the science experiences. Other students will need guidance through questioning such as those in the *Investigations Guide* to make those connections. Allow some time for students to struggle with the problem. If the struggle becomes unproductive, call students to the discussion area and have a short review of the relevant science notebook entries they have made leading up to the day’s work.

**Other strategies for constructing explanations and designing solutions.**

**Generate and/or compare multiple solutions to a problem.**
During the sense-making discussion, students can bring their design solutions and meet with another group. During this meeting, groups can share their solution, how it fits with the criteria and constraints. Depending upon classroom culture, comparisons can be made among groups, however, be sure to keep the focus on discussing the designs, not creating a competition. Model how to listen to other groups and ask probing questions about the different solutions.

Here are other examples of constructing explanations and designing solutions in FOSS grade 1 modules.

- **In the Air and Weather Module**, students construct explanations about the weather conditions during the different seasons.
- **In the Sound and Light Module**, students explain how sound can make objects move without touching them.
- **In the Plants and Animals Module**, students construct explanations based on their observations of how a bulb grows.
Sentence frames for students to use to construct explanations and design solutions.

- I observed _____.
- I think _____ because _____.
- We could solve the problem by _____.
- The best way to solve the problem is _____.

Questions for teachers to ask students about constructing explanations and designing solutions.

- Are you saying _____?
- Does _____ mean that _____?
- Is _____ an example of _____?
- Do you think _____ is a result of _____?
- Which _____ caused _____?
- Does _____ relate to this new situation?
- Is _____ the same or different from _____?
Engaging in Argument from Evidence

Argument in science goes beyond reaching agreements in explanations and design solutions. Whether investigating a phenomenon, testing a design, or constructing a model to provide a mechanism for an explanation, students are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods based on their merits (NGSS Appendices, 2013, page 62).

Argumentation involves the interplay of different explanations (claims and evidence). Good arguments to support claims are based on evidence derived from data, as well as sound reasoning. Ideally, these data come from students’ firsthand experiences, with additional information from peer and teacher input and relevant media. Sometimes students question the relevance or validity of evidence as part of the argumentation process, requiring clarification or refinement of data collection or analysis. Other times, students elucidate and successfully defend the reasoning used in an explanation.

**Working with students engaging in argument from evidence.**

In the process of constructing explanations and sharing designs, students may disagree with other students in the group. Conversations ensue. Students refine explanations when they debate the merits of alternate ideas in informal arguments or when you structure a more formal argument within the class. Allowing students to revisit, revise, and elaborate previous explanations is a desirable progression after scientific argumentation.

Teachers should carefully consider when and how to encourage argumentation to support the learning of science content, especially in first grade. Opportunities to engage students in argumentation, along with suggested strategies below, are indicated in the *Investigations Guide* at specific points in the investigations. Unplanned opportunities or “teachable moments” occasionally present themselves during lessons. Teachers should be ready to encourage students to engage in argumentation to elaborate ideas that emerge spontaneously during discussion.

**Strategies for engaging in argument from evidence.**

**Identify arguments that are supported by evidence.** In order to identify arguments that are supported by evidence, young students need experiences with the concepts they are discussing. Students who can understand the argument will be better able to determine whether it is supported by evidence.

**Appendix F of NGSS identifies student capabilities as they engage in argument from evidence.** None of these appear in the performance expectations for grade 1.

- Identify arguments that are supported by evidence
- Distinguish between explanations that account for all gathered evidence and those that do not.
- Analyze why some evidence is relevant to a scientific question and some is not.
- Distinguish between opinions and evidence in one’s own explanations.
- Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.
- Construct an argument with evidence to support a claim.
- Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.
Present two arguments on the board, one stating a just a claim, the other containing evidence to support a claim. Clarify with students the two statements, such as these from the FOSS Plants and Animals Module.

<table>
<thead>
<tr>
<th>Plants can grow from cuttings. We put a cutting with a node in water and it grew roots, a stem, and leaves.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants can grow from a bulb.</td>
</tr>
</tbody>
</table>

Have students discuss which position tells why the statement may be true. Ask students to think of evidence that plants need light to grow. When students have generated some ideas, return to the two statements on the board and add evidence to support the positions.

Provide additional positions with and without evidence for students to critique. Have them sort statements into those that are supported and those that are not.

**Supported by evidence**

**Not supported by evidence**

Distinguish between explanations that account for all gathered evidence and those that do not. When helping students distinguish between explanations that account for multiple pieces of evidence, consider where students are in their development of the concepts and whether they are aware of all gathered evidence.

During a whole-class discussion, collect data that students have recorded that might help them answer a focus question. Write these data on the board or on chart paper. On another area of the board or another piece of chart paper, record a few explanations that students put forth and/or provide a few of your own. Make sure one example contains robust evidence, one contains sparse evidence, and one is not supported by any data gathered in the investigation. Ask,

- *Which explanations contain evidence?*
- *Which explanations do not contain evidence?*
- *Which explanation includes the most evidence?*

To improve the explanations, read through the potential evidence and ask students if the evidence supports the explanations. Model how to include those pieces of evidence in the explanations.
Analyze why some evidence is relevant to a scientific question and some is not. After posing a question, ask students to think-pair-share what they will need to answer the question. For example, when you ask students what happens when different materials block light, students would identify the shadow or lack of shadow as evidence. Write these on chart paper. The day after students have answered the question in their notebooks, review the initial list of ideas. Prompt students to think about a piece of evidence such as the piece of wood makes a shadow. Ask if this piece of evidence is helpful, or relevant, in identifying what happens when different materials block light. Provide other pieces of evidence for students to assess. Revise the list to indicate the observations that they agree are evidence that supports their answers and those observations that are not.

Distinguish between opinions and evidence in one’s own explanation. Make sure students understand the difference between opinion and scientific evidence. Opinions are based on what a person believes to be true or feels should be true. Evidence is based on observation and scientific data.

Give students a few prompts to generate descriptions that might include an opinion, such as “How would you describe this balloon?” Generate a list of responses on the board, such as “I think it is pretty,” and “The balloon is stretchy.” Have students discuss in small groups, which statements are opinions and which are observations. Underline opinions in red, evidence in blue. As an extension, have students take turns making a statement, which the rest of the group determines to be an opinion or evidence.

Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument. Engaging in argumentation requires students to formulate their own claims, and to focus their attention on other students’ claims. Primary students need a lot of practice to develop these high-level discourse skills. Model and discuss what it looks like and sounds like when people listen to each other, show they understand, ask for clarification, and agree and disagree about ideas. As much as possible, give students the opportunity to discuss their ideas in pairs, small groups, and as a class. Make it a goal to move away from generating the questions yourself to more student-centered discussions, where students are sharing and building on each other’s ideas. Use strategies such as having students ask each other questions and paraphrase what others are saying.

Post icons and/or use hand signals for the different types of discussion moves (agree, disagree, build on, question, etc.) to help students adopt the moves in their own conversations.

What happens when different materials block light?

<table>
<thead>
<tr>
<th>Helpful</th>
<th>Not helpful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood makes a shadow</td>
<td>Looks like a square</td>
</tr>
<tr>
<td>Plastic shadow is gray</td>
<td>Plastic is on the wall</td>
</tr>
</tbody>
</table>

Here is an example of engaging in argument from evidence in FOSS grade 1 modules.

- In the Plants and Animals Module, students engage in argument from evidence to support what happens to plants when they are mowed.
Debrief the process. Ask students how they think the discussion went. What made them think harder or share more during the discussion? How could it be better next time?

Another strategy is to use a discussion protocol, such as A/B partners, for students who have differing ideas. Assign partners so that each student has a different claim. Have student A share his or her thinking while student B listens. Student B responds by paraphrasing what A said and then asking a question that helps the other think more deeply about the claim, such as “Why do you think that? What is your evidence?” They could also ask specific questions.

➤ Why do you think the cuttings with the nodes grew?
➤ Why do you think the vibration goes through the string?
➤ How does your drawing show the moving air?

Students then switch roles. When both partners have shared their claim, students should either reach a common claim or agree to disagree and report back to the class.

Construct an argument with evidence to support a claim. In FOSS, students provide written explanations when answering the focus question. These explanations can be refined through argumentation. Students also present verbal statements during arguments. In both instances, students should construct their arguments by putting forth a claim and supporting evidence.

Their arguments will need development. Model how to write a position and then identify and color-code portions of the arguments. Gather students on the rug, and write an argument statement on the board. Ask students which part of the statement is the claim. When all agree, underline the claim with one color, then underline the evidence statements with another color. As students develop their writing skills, they can begin to use this strategy with their own writing.

At the end of the investigation, write a few claim statements and a few evidence statements on sentence strips. Put the strips on a pocket chart to match up as a class, or give each small group a set to work on together. Students should first determine which statement strips are claims and which constitute evidence. Next, they should match the evidence statements with the claims they support.

Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence. During and after engaging in designing and constructing activities, have students pause to think about what they are basing their decisions on and what
evidence supports those decisions. For example, when constructing their communication device, in the **FOSS Sound and Light Module**, ask students about the materials they choose. Encourage students to cite evidence from what they have learned during the investigation; for example the mirror is shiny so it reflects the light.

Another strategy is to have a design showcase. Exhibit student-designed objects. Students take turns explaining how they designed and built their object, why they think it is effective for the design purpose, and the evidence that supports their claim. Other students can ask questions and provide feedback on effectiveness.

**Sentence frames for students to use to engage in argument from evidence.**

- I claim _____.
- My evidence is _____.
- I agree/disagree with _____ because _____.
- What about_____?
- I used to think _____ but now I think _____.
- My models shows _____.
- My data show _____.

**Questions for teachers to ask students about engaging in argument from evidence.**

- Do you agree or disagree?
- Which explanation makes more sense to you?
- Which piece of evidence supports this claim?
- Is this an opinion or evidence?
- Do you agree or disagree?
Appendix F of NGSS identifies student capabilities as they obtain, evaluate, and communicate information. The one in bold appears in the performance expectations for grade 1.

- **Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).**

- **Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.**

- **Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.**

- **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.**

**Obtaining, Evaluating, and Communicating Information**

Being literate in science and engineering requires the ability to read and understand their literatures. Science and engineering are ways of knowing that are represented and communicated by words, diagrams, charts, graphs, images, symbols, and mathematics. Reading, interpreting, and producing text are fundamental practices of science in particular, and they constitute at least half of engineers’ and scientists’ total working time (A Framework for K–12 Science Education, 2012, page 74).

Students’ first-hand experiences combined with the science and engineering practices are extended by engaging with texts and other sources of information. Skill is required to extract and connect information found in the readings, videos, and other media. Like other sources of information, these too need to be organized, analyzed, and resolved into explanations and arguments. As students communicate their scientific thinking and technical information, they need skills in order to do so effectively whether orally, written, or visually.

**Working with students obtaining, evaluating, and communicating information.**

Obtaining, evaluating, and communicating information in science requires part science practice and part language arts skills. The teacher needs to consider student abilities with reading, writing, speaking, listening, and vocabulary when engaging students with this practice. Scaffolds and modifications may be necessary for students to extract useful information from text and to other media and analyze it with data collected from first-hand experiences. The Investigations Guide provides suggestions for specific instructional strategies for the FOSS readings and media. The Science-Centered Language Development chapter also provides a wealth of strategies for communicating information through speaking and writing. The teacher needs to select the appropriate strategies for their students, monitor progress, and adjust accordingly over the year.

**Example in Grade 1**

Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s). In the Plants and Animals Module, Investigation 3, Part 3, students look at habitat cards and identify which organism belongs in which habitat. In this example, the teacher wants to develop student capability of obtaining information from sources. After students have shared their some initial thinking about the types of plants and animals in a habitat,
Here are other examples of obtaining, evaluating, and communicating information in FOSS grade 1 modules.

- In the **Air and Weather Module**, students obtain, evaluate, and communicate information about the weather.

- In the **Sound and Light Module**, students obtain, evaluate, and communicate information about the different sounds animals make.

- In the **Plants and Animals Module**, students obtain, evaluate, and communicate information from books and media and integrating that with their first-hand experiences to construct explanations about living organisms.

students look at the structures on their particular animal and how that structure helps them survive in that habitat. The teacher can do a think-aloud to model this process.
# SCIENCE AND ENGINEERING PRACTICES OPPORTUNITIES IN FOSS

This is a complete listing of every instance where a science and engineering practice is called out in the sidebar of the FOSS *Investigations Guide*. The ones in bold are the grade-level examples described in this chapter.

<table>
<thead>
<tr>
<th>Practices</th>
<th>Air and Weather Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask questions based on observations to find more information about the natural world.</td>
<td>Inv 4, Part 2, Step 7: Generate questions</td>
</tr>
<tr>
<td>Define a simple problem that can be solved through the development of a new or improved object or tool.</td>
<td>Inv 1, Part 2, Step 25: Assess progress: performance assessment</td>
</tr>
<tr>
<td>Ask and/or identify questions that can be answered by an investigation.</td>
<td>Inv 4, Part 2, Step 7: Generate questions</td>
</tr>
<tr>
<td>Distinguish between a model and the actual object, process, and/or events the model represents.</td>
<td>Inv 2, Part 2, Steps 7-8: Introduce the demonstration thermometer/Return to class Inv 2, Part 2, Step 12: Record the temperature</td>
</tr>
<tr>
<td>Develop and/or use a model to represent amounts, relationships, relative scales, and/or patterns in the natural world.</td>
<td>Inv 1, Part 2, Step 25: Assess progress: performance assessment Inv 1, Part 4, Step 19: Distribute the notebook sheet Inv 2, Part 2, Steps 7-8: Introduce the demonstration thermometer/Return to class Inv 2, Part 2, Step 12: Record the temperature Inv 3, Part 2, Step 3: Introduce the wind scale</td>
</tr>
</tbody>
</table>

Full Option Science System
<table>
<thead>
<tr>
<th>Sound and Light Module</th>
<th>Plants and Animals Module</th>
</tr>
</thead>
</table>
| Inv 2, Part 1, Step 1: Introduce loud and soft sounds  
Inv 2, Part 4, Step 1: Review sound  
Inv 2, Part 4, Step 11: Assess progress: performance assessment  
Inv 4, Part 1, Step 1: Introduce the mirror  
Inv 4, Part 1, Step 7: Have a sense-making discussion  
Inv 4, Part 2, Step 5: Visit students as they work  
Inv 4, Part 2, Step 9: Compare two shapes  
Inv 4, Part 4, Step 8: Assess progress: performance assessment | Inv 1, Part 1, Step 20: Have a sense-making discussion  
Inv 1, Part 2, Step 13: Have a sense-making discussion  
Inv 1, Part 3, Step 14: Assess progress: performance assessment  
Inv 2, Part 1, Step 12: Observe changes  
**Inv 2, Part 1, Step 13:** Encourage students to ask questions  
Inv 2, Part 2, Step 17: Assess progress: performance assessment  
Inv 2, Part 3, Step 12: Observe growth over time  
Inv 3, Part 2, Step 19: Have a sense-making discussion  
Inv 4, Part 3, Step 10: Generate questions about adopted plants |
| Inv 2, Part 3, Step 6: Focus question: How does sound travel from the source to the receiver?  
Inv 2, Part 3, Step 10: Have a sense-making discussion  
Inv 2, Part 4, Step 5: Have a sense-making discussion  
Inv 2, Part 4, Step 9: Model the steps (guided engineering)  
Inv 4, Part 1, Step 15: Answer the focus question  
Inv 4, Part 4, Step 5: Introduce the two mirror challenge  
Inv 4, Part 4, Step 8: Assess progress: performance assessment | Inv 1, Part 3, Step 13: Record growth and label straws  
Inv 3, Part 1, Step 12: Assess progress: performance assessment  
**Inv 3, Part 2, Step 2:** Record changes on a new terrarium map |

*Science and Engineering Practices—Grade 1*
## Science and Engineering Practices—Grade 1

### Practices

<table>
<thead>
<tr>
<th>Practices</th>
<th>Air and Weather Module</th>
</tr>
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<tbody>
<tr>
<td>Compare models to identify common features and differences.</td>
<td>Inv 1, Part 2, Step 25: Assess progress: performance assessment</td>
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<td>Inv 1, Part 4, Step 19: Distribute the notebook sheet</td>
</tr>
<tr>
<td>Make observations (firsthand) to collect data that can be used to make comparisons.</td>
<td>Inv 1, Part 1, Step 7: Explore objects</td>
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<td>Inv 1, Part 2, Step 11: Go outdoors</td>
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<tr>
<th>Sound and Light Module</th>
<th>Plants and Animals Module</th>
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<tbody>
<tr>
<td>Inv 2, Part 3, Step 6: Focus question: How does sound travel from the source to the receiver?</td>
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<td>Inv 2, Part 3, Step 10: Have a sense-making discussion</td>
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<td>Inv 2, Part 4, Step 5: Have a sense-making discussion</td>
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<tr>
<td>Inv 2, Part 4, Step 9: Model the steps (guided engineering)</td>
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<tr>
<td>Inv 4, Part 1, Step 15: Answer the focus question</td>
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<td>Inv 4, Part 4, Step 5: Introduce the two mirror challenge</td>
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## Science and Engineering Practices—Grade 1

### Practices

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<th>Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.</th>
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### Air and Weather Module

- Inv 1, Part 1, Step 5: Discuss observations
- Inv 1, Part 1, Step 12: Introduce the book fiddle
- Inv 1, Part 2, Step 6: Demonstrate drop challenge
- Inv 1, Part 2, Step 10: Assess progress: performance assessment
- Inv 1, Part 3, Step 7: Listen and remember sounds
- Inv 2, Part 1, Step 7: Ask questions about the xylophone
- Inv 2, Part 2, Step 5: Describe pitch challenges
- Inv 2, Part 2, Step 13: Assess progress: performance assessment
- Inv 2, Part 3, Step 3: Describe the volume challenge
- Inv 3, Part 1, Step 7: Introduce objects
- Inv 3, Part 2, Step 4: Describe the outdoor challenges
- Inv 3, Part 2, Step 8: Assess progress: performance assessment
- Inv 3, Part 3, Step 8: Distribute materials
- Inv 4, Part 1, Step 5: Visit students as they work
- Inv 4, Part 1, Step 12: Assess progress: performance assessment
- Inv 4, Part 2, Step 5: Visit students as they work
- Inv 4, Part 3, Step 7: Discuss first viewings
- Inv 4, Part 3, Step 8: Shine a little light in the box
- Inv 4, Part 4, Step 8: Assess progress: performance assessment
- Inv 1, Part 1, Step 4: Demonstrate the planting procedure
- Inv 1, Part 1, Step 12: Discuss the watering procedure
- Inv 1, Part 1, Step 20: Have a sense-making discussion
- Inv 1, Part 2, Step 1: Discuss student observations
- Inv 1, Part 2, Step 5: Describe the mowing procedure
- Inv 1, Part 3, Step 7: Position seeds and describe relative position
- Inv 1, Part 3, Step 14: Assess progress: performance assessment
- Inv 1, Part 4, Step 7: Begin the plant hunt
- Inv 2, Part 1, Step 9: Add water to the cups
- Inv 2, Part 2, Step 7: Introduce the planting procedure
- Inv 2, Part 3, Step 6: Remove cuttings from the cups
- Inv 2, Part 3, Step 12: Observe growth over time
- Inv 3, Part 1, Step 10: Describe planting
- Inv 3, Part 2, Step 19: Have a sense-making discussion
- Inv 4, Part 1, Step 10: Observe growth 3 days later
- Inv 4, Part 2, Step 5: Assign plants
- Inv 4, Part 2, Step 11: Assess progress: performance assessment
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### Science and Engineering Practices — Grade 1

**Practices**

- **Record information (observations, thoughts, and ideas).**
  - Inv 1, Part 1, Step 13: Answer the focus question
  - Inv 1, Part 2, Step 25: Assess progress: performance assessment
  - Inv 1, Part 3, Steps 10-12: Have a sense-making discussion
  - Inv 2, Part 2, Step 12: Record the temperature
  - Inv 2, Part 3, Step 9: Have a sense-making discussion
  - Inv 2, Part 4, Step 14: Have a sense-making discussion
  - **Inv 3, Part 2, Step 11: Answer the focus question**
  - Inv 3, Part 3, Step 7: Assess progress: performance assessment
  - Inv 3, Part 4, Step 7: Observe cloud movement
  - Inv 3, Part 5, Step 9: Have a sense-making discussion
  - Inv 4, Part 1, Step 5: Assess progress: performance assessment
  - Inv 4, Part 1, Step 10: Have a sense-making discussion
  - Inv 4, Part 2, Step 7: Generate questions
  - Inv 4, Part 3, Step 6: Compare the graphs at the end of the season

- **Use and share pictures, drawings, and/or writings of observations.**
  - Inv 1, Part 1, Step 13: Answer the focus question
  - Inv 1, Part 2, Step 25: Assess progress: performance assessment
  - Inv 1, Part 3, Steps 10-12: Have a sense-making discussion
  - Inv 2, Part 2, Step 12: Record the temperature
  - Inv 2, Part 3, Step 9: Have a sense-making discussion
  - Inv 2, Part 4, Step 14: Have a sense-making discussion
  - **Inv 3, Part 2, Step 11: Answer the focus question**
  - Inv 3, Part 3, Step 7: Assess progress: performance assessment
  - Inv 3, Part 4, Step 7: Observe cloud movement
  - Inv 3, Part 5, Step 9: Have a sense-making discussion
  - Inv 4, Part 1, Step 5: Assess progress: performance assessment
  - Inv 4, Part 1, Step 10: Have a sense-making discussion
  - Inv 4, Part 2, Step 7: Generate questions
  - Inv 4, Part 3, Step 6: Compare the graphs at the end of the season
### Sound and Light Module

- Inv 1, Part 1, Step 12: Introduce the book fiddle
- Inv 1, Part 3, Step 7: Listen and remember sounds
- Inv 2, Part 1, Step 9: Discuss observations
- Inv 2, Part 2, Step 13: Assess progress: performance assessment
- Inv 2, Part 3, Step 3: Describe the volume challenge
- Inv 3, Part 1, Step 10: Have a sense-making discussion
- Inv 3, Part 2, Step 8: Assess progress: performance assessment
- Inv 3, Part 3, Step 13: Answer the focus question
- Inv 4, Part 1, Step 7: Have a sense-making discussion
- Inv 4, Part 2, Step 9: Compare two shapes
- Inv 4, Part 3, Step 8: Shine a little light in the box
- Inv 4, Part 4, Step 8: Assess progress: performance assessment

### Plants and Animals Module

- Inv 1, Part 2, Step 1: Discuss student observations
- Inv 1, Part 2, Step 8: Return lawns to tray
- Inv 1, Part 2, Step 12: Assess progress: notebook entry
- Inv 1, Part 3, Step 14: Assess progress: performance assessment
- Inv 1, Part 4, Step 7: Begin the plant hunt
- Inv 2, Part 1, Step 12: Observe changes
- Inv 2, Part 3, Step 12: Observe growth over time
- Inv 3, Part 2, Step 2: Record changes on a new terrarium map
- Inv 3, Part 4, Step 12: Have a sense-making discussion
- Inv 4, Part 1, Step 13: Observe growth 8-10 days later

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*Science and Engineering Practices—Grade 1*
# Science and Engineering Practices—Grade 1

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| Use observations (firsthand or from media) to describe patterns and/or relationships in the natural world in order to answer scientific questions and solve problems. | Inv 1, Part 1, Step 13: Answer the focus question  
Inv 1, Part 2, Step 25: Assess progress: performance assessment  
Inv 1, Part 3, Steps 10-12: Have a sense-making discussion  
Inv 2, Part 2, Step 12: Record the temperature  
Inv 2, Part 3, Step 9: Have a sense-making discussion  
Inv 2, Part 4, Step 14: Have a sense-making discussion  
**Inv 3, Part 2, Step 11: Answer the focus question**  
Inv 3, Part 3, Step 7: Assess progress: performance assessment  
Inv 3, Part 4, Step 7: Observe cloud movement  
Inv 3, Part 5, Step 9: Have a sense-making discussion  
Inv 4, Part 1, Step 5: Assess progress: performance assessment  
Inv 4, Part 1, Step 10: Have a sense-making discussion  
Inv 4, Part 2, Step 7: Generate questions  
Inv 4, Part 3, Step 6: Compare the graphs at the end of the season |
| Analyze data from tests of a tool to determine if it works as intended.   | **Inv 3, Part 2, Step 11: Answer the focus question**  
Inv 3, Part 3, Step 7: Assess progress: performance assessment  
Inv 3, Part 4, Step 7: Observe cloud movement  
Inv 3, Part 5, Step 9: Have a sense-making discussion |
| Compare predictions to what occurred.                                    |                                                                                       |
| Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs. | Inv 4, Part 1, Step 5: Assess progress: performance assessment  
Inv 4, Part 2, Step 7: Generate questions  
Inv 4, Part 3, Step 6: Compare the graphs at the end of the season |
| Use counting and numbers to identify and describe patterns in the natural and designed world(s). | Inv 2, Part 2, Step 8: Return to class                                                  |
### Sound and Light Module

- Inv 1, Part 1, Step 12: Introduce the book fiddle
- Inv 1, Part 3, Step 7: Listen and remember sounds
- Inv 2, Part 1, Step 9: Discuss observations
- Inv 2, Part 2, Step 13: Assess progress: performance assessment
- Inv 2, Part 3, Step 3: Describe the volume challenge
- Inv 3, Part 1, Step 10: Have a sense-making discussion
- Inv 3, Part 2, Step 8: Assess progress: performance assessment
- Inv 3, Part 3, Step 13: Answer the focus question
- Inv 4, Part 1, Step 7: Have a sense-making discussion
- Inv 4, Part 2, Step 9: Compare two shapes
- Inv 4, Part 3, Step 8: Shine a little light in the box

### Plants and Animals Module

- Inv 1, Part 2, Step 1: Discuss student observations
- Inv 1, Part 2, Step 8: Return lawns to tray
- Inv 1, Part 2, Step 12: Assess progress: notebook entry
- Inv 1, Part 3, Step 14: Assess progress: performance assessment
- Inv 1, Part 4, Step 7: Begin the plant hunt
- Inv 2, Part 1, Step 12: Observe changes
- Inv 2, Part 3, Step 12: Observe growth over time
- Inv 3, Part 2, Step 2: Record changes on a new terrarium map
- Inv 3, Part 4, Step 12: Have a sense-making discussion
- Inv 4, Part 1, Step 13: Observe growth 8-10 days later

- Inv 1, Part 3, Step 7: Listen and remember sounds
- Inv 2, Part 1, Step 9: Discuss observations
- Inv 2, Part 2, Step 13: Assess progress: performance assessment
- Inv 2, Part 3, Step 12: Observe growth over time
- Inv 3, Part 4, Step 12: Have a sense-making discussion
- Inv 4, Part 1, Step 13: Observe growth 8-10 days later

- Inv 1, Part 3, Step 14: Assess progress: performance assessment
- Inv 3, Part 4, Step 12: Have a sense-making discussion
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<td>Inv 4, Part 2, Step 10: Assess progress: notebook entry</td>
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<td>Inv 4, Part 3, Steps 9-10: Read and discuss “Seasons”</td>
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<td>Construct an argument with evidence to support a claim.</td>
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<tr>
<td>Sound and Light Module</td>
<td>Plants and Animals Module</td>
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<tr>
<td>Inv 1, Part 2, Step 10: Assess progress: performance assessment</td>
<td>Inv 1, Part 2, Step 13: Have a sense-making discussion</td>
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<tr>
<td><strong>Inv 1, Part 2, Step 21: Use lid with salt and rice</strong></td>
<td>Inv 1, Part 2, Step 15: Clean up</td>
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<tr>
<td>Inv 2, Part 1, Step 12: Answer the focus question</td>
<td>Inv 1, Part 3, Step 14: Assess progress: performance assessment</td>
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<td>Inv 2, Part 2, Step 13: Assess progress: performance assessment</td>
<td>Inv 1, Part 3, Step 16: Discuss wheat growth after 2 weeks</td>
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<td>Inv 2, Part 3, Step 13: Answer the focus question</td>
<td>Inv 2, Part 1, Step 17: Have a sense-making discussion</td>
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<td>Inv 2, Part 4, Step 1: Review sound</td>
<td>Inv 2, Part 3, Step 12: Observe growth over time</td>
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<td>Inv 2, Part 4, Step 5: Have a sense-making discussion</td>
<td>Inv 2, Part 3, Step 9: Distribute terrarium maps</td>
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<td>Inv 2, Part 4, Step 9: Model the steps (guided engineering)</td>
<td>Inv 2, Part 3, Step 24: Add survival to the content grid</td>
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<tr>
<td><strong>Inv 3, Part 1, Step 10: Have a sense-making discussion</strong></td>
<td>Inv 3, Part 3, Step 9: View video</td>
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<td>Inv 3, Part 1, Step 11: Make predictions about shadows</td>
<td>Inv 3, Part 4, Step 12: Have a sense-making discussion</td>
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<td>Inv 4, Part 2, Step 17: Have a sense-making discussion</td>
<td><strong>Inv 4, Part 2, Step 18: Have a sense-making discussion</strong></td>
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<td>Inv 4, Part 3, Step 8: Shine a little light in the box</td>
<td>Inv 4, Part 3, Step 13: Display the results</td>
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<td>Inv 4, Part 3, Steps 13-15: Read and discuss “Seeing the Light”</td>
<td>Inv 4, Part 3, Step 19: Assess progress: notebook entry</td>
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<td><strong>Inv 4, Part 4, Step 13: Describe the challenge and the constraints</strong></td>
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<td>Inv 1, Part 2, Step 13: Have a sense-making discussion</td>
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*Science and Engineering Practices—Grade 1*
## Science and Engineering Practices—Grade 1

<table>
<thead>
<tr>
<th>Practices</th>
<th>Air and Weather Module</th>
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<tbody>
<tr>
<td><strong>Obtaining, evaluating, and communicating information</strong>&lt;br&gt;Read grade-appropriate text and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).</td>
<td>Inv 1, Part 2, Steps 18-20: Read and discuss “What Is All around Us?”&lt;br&gt;Inv 2, Part 4, Steps 7-9: Read and discuss “Changes in the Sky”&lt;br&gt;Inv 4, Part 3, Steps 11-12: Read and discuss “Getting through the Winter”</td>
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<tr>
<td>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.</td>
<td>Inv 1, Part 2, Step 17: Answer the focus question&lt;br&gt;Inv 1, Part 2, Steps 18-20: Read and discuss “What Is All around Us?”&lt;br&gt;Inv 2, Part 4, Steps 7-9: Read and discuss “Changes in the Sky”&lt;br&gt;Inv 3, Part 3, Step 7: Assess progress: performance assessment&lt;br&gt;Inv 4, Part 3, Steps 13-15: Read and discuss “Seeing the Light”&lt;br&gt;Inv 4, Part 4, Steps 20-22: Read and discuss “Communicating with Light”</td>
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### Sound and Light Module

| Inv 1, Part 1, Steps 8-9: Vibrations and Sound | Inv 1, Part 2, Steps 22-24: Read and discuss “Listen to This” |
| Inv 2, Part 2, Step 13: Assess progress: performance assessment | Inv 2, Part 2, Steps 14-16: Read and discuss “Strings in Motion” |
| Inv 2, Part 2, Steps 15-17: Read and discuss “More Musical Instruments” | Inv 3, Part 2, Steps 14-16: Read and discuss “Playing in the Light” |
| Inv 3, Part 3, Step 15: View summary video | Inv 3, Part 3, Steps 13-15: Read and discuss “Seeing the Light” |
| Inv 4, Part 4, Steps 20-22: Read and discuss “Communicating with Light” |

### Plants and Animals Module

| Inv 1, Part 1, Steps 24-26: Read and discuss “What Do Plants Need?” | Inv 1, Part 3, Steps 20-21: Read and discuss “The Story of Wheat” |
| Inv 1, Part 4, Step 17: View video | Inv 3, Part 1, Step 12: Assess progress: performance assessment |
| Inv 3, Part 2, Steps 22-23: Read and discuss “Plants and Animals around the World” | Inv 3, Part 2, Step 26: Describe a habitat |

**Inv 3, Part 3, Step 5: Match cards**

| Inv 3, Part 3, Steps 16-17: Read and discuss “Learning from Nature” | Inv 4, Part 3, Steps 15-16: Read and discuss “Animals and Their Young” |