INTRODUCTION—GRADE 4

In FOSS, sense-making discussion is a prominent part of active investigation. The sense-making discussion follows the context setting, activity, data acquisition and management, and is a critically important part of the analysis process. The following vignette describes a sense-making discussion.

Students have conducted an investigation testing how energy transfers in systems during collisions. They release different masses of balls from different heights on a ramp. The ball collides with a cork and pushes the cork a certain distance. After sharing their observations, students bring their notebooks to the discussion area and stand shoulder to shoulder next to someone from another group. The teacher asks students to consider how one of the variables (mass of ball) affects the distance the cork is pushed. Students turn and talk to a partner while another pair of students add their observations to the class notebook. A few students share that as the mass of the ball increases, the distance the cork moves increases. Other students agree and others ask questions. The teacher listens and asks questions to guide the discussion or encourages communication between all students, careful to
facilitate rather than lead. Students collaboratively develop models about why the cork moves a farther distance with some conditions than others. Data from the class notebook are compared to those in student notebooks and used as evidence to support student models and explanations. A few students share their models in the class notebook. Students all work to refine their models and construct explanations about the energy transfer in the systems. Using this understanding, students consider how energy is transferred in other systems. Before heading back to their seats and responding to the focus question individually in their notebook, students summarize their current understanding with a partner.

A sense-making discussion, like the one described above, has two purposes. First, it helps students review and confirm information accrued from the active investigation, and to organize information for processing. It is more than just sharing what they did or observed; more importantly, it is analysis—finding connections and relationships in the data in an effort to construct conceptual knowledge. Second, this discussion helps students organize and communicate their thinking in collaboration with their peers. The sense-making discussion allows all students to develop conceptual models about phenomena and prepares them to respond to the FOSS focus question.

This chapter describes a professional learning process to enhance your abilities to facilitate sense-making discussions of science phenomena with grade 4 students. This chapter will be most useful after you have taught a FOSS module.
PLANNING AND PREPARING FOR SENSE-MAKING DISCUSSIONS

We have identified six planning steps to prepare for a sense-making discussion. We will describe each step and then provide a typical planning schematic that summarizes the process. At the end of this chapter are seven samples of model sense-making planning guides for grade 4 investigation discussions. References to these planning guides are found in the sidebars of the Investigations Guide.

1. **Review the Investigations Guide**

Look closely at the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCs) associated with a particular lesson. These are stated on the first page of the investigation and discussed in the Teaching Children about section. Review the guiding questions for the investigation (on the first page and in the at-a-glance chart), the Background for the Teacher, and the Teaching Children about . . . section for cognitive engagement that is critical for student understanding. Note relevant questions or talking points in these sections, and pay particular attention to common emerging conceptions that can be used to generate argumentation.
The Teaching Children about . . . section provides information about the DCIs, SEPs, and CCs emphasized in the investigation.

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**Background for the Teacher**

**Engaging in Science and Engineering Practices (SEP)**

- Asking questions about the energy of moving things down ramps and designing experiments to produce data to serve as the basis for evidence.
- Planning and carrying out investigations dealing with the effects of balls of different masses released from different starting positions on a ramp. Collaboratively plan an investigation, controlling variables, collecting data, and using the data to make predictions about what would happen if one variable was changed.
- Analyzing and interpreting data by using tables to reveal patterns of transfer of energy from balls of different masses to a stationary cork. Comparing the data collected independently by several groups to discuss similarities and differences in the data displayed in the data tables.
- Using mathematics and computational thinking in organizing quantitative data to reveal patterns that suggest a relationship between the energy transferred when variables are changed.
- Constructing explanations using evidence, such as the relationship between the potential energy and kinetic energy of balls rolling down ramps.
- Engaging in argument from evidence about the presence of energy in different systems.
- Obtaining, evaluating, and communicating information from books and videos and integrating that with their firsthand experiences to construct explanations about energy transfer and forces.

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**NGSS Foundation Rationale for SEP**

- Ask questions that can be investigated based on patterns such as cause-and-effect relationships.
- Plan and conduct an investigation collaboratively to collect data to serve as the basis for evidence, using tools and techniques controlled and the number of trials considered.
- Make observations and/or measurements to produce data to serve as the basis for evidence on an exploration of a phenomenon in text and design solution.
- Make predictions about what would happen if a variable changes.
- Represent data in tables and/or science graphical displays to reveal patterns that indicate relationships.
- Analyze and interpret data to make sense of phenomena using logical reasoning.
- Construct an explanation of observed relationships.
- Compare and contrast data collected by different groups to identify trends in their findings and differences in their findings.
- Use evidence (i.e., observations, patterns) to support an explanation.
- Identify the evidence that supports particular points in an explanation.
- Construct an argument based on evidence, data, and/or models.
- Obtain and combine information from books and other reliable media to explain phenomena.
- Communicate scientific information orally and/or in written form.

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**Sense-Making Discussions for Three-Dimensional Learning**

In this investigation, students engage in these practices:

- Using mathematics and computational thinking in organizing quantitative data to reveal patterns that suggest a relationship between the potential energy and kinetic energy of balls rolling down ramps.
- Engaging in argument from evidence about the presence of energy in different systems.
- Asking questions about the energy of moving things down ramps and designing experiments to produce data to serve as the basis for evidence.
- Planning and carrying out investigations dealing with the effects of balls of different masses released from different starting positions on a ramp. Collaboratively plan an investigation, controlling variables, collecting data, and using the data to make predictions about what would happen if one variable was changed.
- Analyzing and interpreting data by using tables to reveal patterns of transfer of energy from balls of different masses to a stationary cork. Comparing the data collected independently by several groups to discuss similarities and differences in the data displayed in the data tables.
- Using mathematics and computational thinking in organizing quantitative data to reveal patterns that suggest a relationship between the potential energy and kinetic energy of balls rolling down ramps.
- Engaging in argument from evidence about the presence of energy in different systems.
Knowing where concepts are addressed and how they are related helps determine what ideas to pursue during the discussion and which ones can be addressed during the next part.

Sense-Making Discussions for Three-Dimensional Learning—Grade 4
2. Identify When and Why to Have the Discussion

Most investigation parts have a step where the class discusses the body of acquired information. The step may not always instruct you to organize students in a circle, but that is generally advisable. The sense-making discussion may be contained within a step, or may take place over several steps. Consider doing this when students have acquired sufficient experience and information and are ready to think about and answer the focus question. A sense-making discussion should happen after data acquisition in preparation for generating an answer to the focus question. For grade 4, plan about 10 minutes for the sense-making discussion.

To illustrate this process we will use an example from the Energy Module, Investigation 4, Energy Transfer, Part 3: Collisions. The page below shows the location of the sense-making discussion after the data collection.

During the sense-making discussion, the role of the teacher is to facilitate the discussion. The teacher asks questions, listens to students, and adjusts depending on the discussion. In the Investigations Guide, certain steps have detailed questions to help students analyze data. Other steps help to identify important ideas that need to come out during the discussion. Review those questions and the important ideas and plan additional question that will guide students toward the desired understandings (DCIs).
3. Plan What to Ask and What to Listen For

There are different levels of questions that will facilitate the discussion. If data have not been shared prior to the sense-making discussion, start with data questions. Plan on asking for observations and have students display those observations in the class notebook. After asking questions about observations, plan questions targeted to the content (disciplinary core ideas) that build on complexity.

Other questions should utilize a crosscutting concept. For example, “What is the function of the claw structure?” or “What causes a canyon to form?” Some of these questions might be found in the Background for the Teacher and the Teaching Children About section. The focus question might be an analysis question. Generating this list of possible questions to ask during the sense-making discussion keeps the discussion focused and students engaged. See the list of teacher generated sample questions in the sidebar.

In addition to the questions, develop a list of the ideas or responses to these questions. This is what you will listen for during the discussion. Look at the What to Look For section or particular steps in the Investigations Guide for that part for possible anticipated responses, including common emergent conceptions.

Some teachers identify the “What to Listen For” first and then develop questions to elicit those ideas. Be certain the questions and the desired ideas match the goals or outcomes for the lesson. See the list of teacher generated responses to questions in the sidebar.

What to ask

➤ As the starting position of the ball increases, what is the effect on the distance the cork moves?
➤ What evidence do you have that supports this? What patterns do you notice that tells you this?
➤ As the mass of the ball increases, what is the effect on the distance the cork moves?
➤ What evidence do you have that supports this? What patterns do you notice that tells you this?
➤ How was energy transferred in this system?

What to listen for

• The higher the starting point, the greater the distance the cork travels.
• The greater the mass, the greater the distance the cork travels.
• The kinetic energy of the ball is transferred to the cork by contact when they collide.
• The size (mass) of the ball and the position from which it starts rolling (its potential energy) are the two variables affecting energy of the ball.
4. Plan for Adjustments

Since students might address ideas before questions are asked, there is not always a linear line of questions and answers. The sense-making discussion is not a question-and-answers session, but rather a student discussion about the data, managed but not led by the teacher. Having a list of the ideas you are listening for helps determine if students’ ideas are heading in a productive direction.

**Scaffolding questions.** If the discussion needs to be further guided or redirected, adjust as necessary using scaffolding questions. As part of your planning, develop questions to scaffold the discussion, and be prepared to redirect the discussion if it is heading in an unproductive direction. Use questions that ask for data to support students’ conclusions. It is always helpful to ask students to support their thinking or the thinking of others with supporting data (evidence).

**Application questions.** Next, plan application or extending questions. In some contexts, these questions connect student thinking to the guiding question for the investigation, bigger ideas, or a new context. For example, “You claim that brine shrimp have a range of tolerance for salinity. What other environmental factors might the brine shrimp have a range of tolerance for?” or “Jenny said that rocks break apart when they roll downhill. Do you think big rocks break into smaller ones where there is no hill? Why?” When appropriate, revisit the phenomenon or guiding questions for the investigation and raise culturally relevant questions that connect concepts to students’ experiences. Look at the Wrap-Up/Warm-Up section for some of these questions. These questions push students’ conceptual models. At times it is appropriate for students to be thinking about these application questions well after the sense-making discussion takes place.

**Other instructional strategies.** Depending on the focus crosscutting concepts and science and engineering practices, other instructional strategies can be incorporated into the discussion. For example, the teacher can provide a claim that differs from the claim students are making in the discussion. This claim serves as a critical competitor, an argumentation strategy designed to fine tune students’ claim. Additionally, an effect-and-cause chart could be made to help students look at specific relationships between variables. Examples of these instructional strategies can be found in the Science and Engineer Practices and Crosscutting Concept chapters. The next-step strategies found in the Assessment and Science Notebook chapters can also be incorporated into sense-making discussions when appropriate.

**Talk moves.** Talk moves serve to help all students communicate with each other and advance their models. Several talk moves are possible.
### SENSE-MAKING DISCUSSION PLANNING GUIDE

**Module**  
Energy

**Investigation 4: Energy Transfer, Part 3:** Collisions

**Guiding question:** How does energy transfer between objects or systems?

**Focus question:** What happens when objects collide?

### NEXT GENERATION SCIENCE STANDARDS

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<th>Focus DCI(s)</th>
<th>Focus SEP(s)</th>
<th>Focus CCs</th>
</tr>
</thead>
</table>
| Conversation of energy and energy transfer (PS3.B) | Constructing explanations and using evidence to support an explanation. | Patterns  
Cause and effect  
Energy and matter |

### Questions and What to Listen for

**Steps 10–13:** Have a sense-making discussion

**What to ask**

- As the starting position of the ball increases, what is the effect on the distance the cork moves? *(Constructing explanations; cause and effect)*
- What evidence do you have that supports this? What patterns do you notice that tells you this? *(Constructing explanations; patterns)*
- As the mass of the ball increases, what is the effect on the distance the cork moves? *(Constructing explanations; cause and effect)*
- What evidence do you have that supports this? What patterns do you notice that tells you this? *(Constructing explanations; patterns)*
- How was energy transferred in this system? *(Constructing explanations; energy and matter)*
- What two variables affect the energy of a ball rolling down a ramp? *(Energy and matter)*
- Which system had the most energy transfer? *(Energy and matter)*
- What evidence do you have that supports this? *(Constructing explanations)*

**What to listen for**

- The higher the starting point, the greater the distance the cork travels.
- The greater the mass, the greater the distance the cork travels.
- The kinetic energy of the ball is transferred to the cork by contact when they collide.
- The size (mass) of the ball and the position from which it starts rolling (its potential energy) are the two variables affecting energy of the ball.
- The largest ball starting at the highest position has the most kinetic energy.

**Scaffolding questions**

- When the large ball was released from a low position, how far did the cork move?  
  *These are questions to ask if students need guidance when processing data and the intended responses are not being heard.*
- When the large ball was released from a low position, did it move a long way or not?  
  *These questions are designed to extend knowledge beyond the discreet experience for the lesson.*
- How are we measuring the energy transfer in this system?

**Application questions**

- What could we change to increase the amount of energy transfer?
- How could we use this information to explain the effect on the pins when we are bowling?
- What does this tell us about how energy transfers during other collisions?
Two talk moves can be used to help begin a sense-making discussion.

- Use partner talk when starting the discussion or when there is a lull in the action. Always start the group discussion with a quick “turn and talk to your neighbor.” This will loosen students up and give them oral practice. This move is very beneficial for students who need more support with language. It often makes sense to have students stand next to and talk with someone they did not work with in their group. You can also use a protocol such as an A/B partner talk dyad or a group sentence starter (see the Science-Centered Language Development chapter for more information). Let students know how long the partner discussion will be and the importance of listening and responding to each other.

- Wait time often works well with students. Initially some students might find these discussions very uncomfortable, but don’t interrupt this struggle too soon. Students need time to process, reflect, and mount the courage to speak up.

Some talk moves are most useful when adjusting the discussion so students discuss the ideas of others. *Talk Science Primer* explains how talk moves progress from pushing individual thinking, to listening to others, to deepening reasoning, and to engaging with others’ reasoning. Try to move beyond having students listening to others just so they know when it is their turn to talk. Students should listen actively and critically and link their ideas to the ideas of others. As you prepare for using the talk moves, start with just a few. *Talk Science Primer* describes two examples that are very effective talk moves to use when students start thinking about analysis and application questions. The first one is Say More and Explain What Someone Else Means; the second move is to Agree/Disagree and Why. Using Asking for Evidence or Reasoning is an effective talk move in which students are asked to reference specific observations or explain a line of thinking.

Talk moves should be considered thoughtfully and selectively, and applied strategically to get students engaged in productive discourse.
5. Consider Language and Vocabulary

Sometimes it is advisable to formally develop precise vocabulary during the sense-making discussion. At other times, students develop those vocabulary words in the context of active investigation. Having these vocabulary words in mind and publicly displayed in the classroom can be helpful. If students are not using academic science vocabulary, adjust the discussion by asking them to rephrase statements, using the academic vocabulary.

With English learners, provide sentence frames to share data or share their thinking. You could use sentence strips for starters that connect with the talk moves. This could become a focus during the discussion. For example, give a sentence starter, such as “What I hear you saying is ______,” when a student is responding to other students. Incorporate accommodations and modifications as necessary to provide all students equal access to and participation in the discussion. See the Access and Equity chapter for more information on ways to support all students.

6. Use a Class Notebook

Students should bring their science notebook and a pen or pencil to the sense-making discussion. For efficiency, you can use a large class notebook during the discussion, typically on a flip chart. Plan a position for the class notebook so that everyone has access to the content. For more information, refer to the Science Notebooks in Grades 3-5 chapter in Teacher Resources. Think about what data should be recorded in the class notebook for display during the sense-making discussion. Try to find time for a few students to record their data in the class notebook. This could be done during the initial partner talk or when students are collecting their data during the active investigation. Allow students to use the class notebook when discussing data. The class notebook can be used to reorganize data to determine patterns or describe cause-and-effect relationships.

The teacher might interact with the class notebook to model a particular data processing technique or call attention to a specific detail.

**Sentence frames.** These samples can be posted as a scaffold as students learn and practice their reasoning and participation skills.

- I think ______, because ______.
- I claim ______; my evidence is ______.
- I agree with ______ that ______.
- My idea is similar/related to ______’s idea.
- <Name> shared _____ with me.
- We decided/agreed that ______.
- Our group sees it differently, because ______.
- We have different observations/results. Some of us found that ______. One group member thinks that ______.
- We had a different approach/idea/solution/answer ______.
CONDUCTING A SENSE-MAKING DISCUSSION

Gathering in a circle is critical for sense-making discussions. Students should sit on the floor or in chairs or stand shoulder to shoulder so everyone can see each other and the class notebook. You should be part of the circle. Depending upon the need for the class notebook, you might stand near it, but not next to it. One goal of the circle is to remove you from the position of “teacher” and the one who “runs” the discussion and has all the answers.

Additionally, you should encourage students to look at and talk to each other rather than to you.

Work with students to generate a list of their responsibilities and ways they should contribute to the conversations. Examples are displayed on the posters below.

Make sure students have visual access to the established class norms, sentence frames, word wall, class notebook, equipment photo cards, and, when appropriate, a reference set of the materials used during the investigation.

Frequency

The goal is to answer the focus question with one rich sense-making discussion in every part of every investigation. This might take time to achieve, so don’t feel you need to do this as a new FOSS user. Start with one for each investigation and add more as you
develop your facilitation skills and students develop their participation skills. In some parts, especially in life science modules, students will discuss data from long-term observations. While this might add additional time, having a rich sense-making discussion will go a long way to improving students’ conceptual understanding and decrease the need for next-step strategies.

Your Role during the Discussion

Move to the location in your classroom where everyone can sit or stand in a circle, preferably without furniture or other visual distraction in the circle. Bring your planning documents that contain the list of questions and what to listen for to the discussion. If you have any additional materials, such as chart, or equipment, bring those as well.

Begin by reviewing with students the discussion norms and sentence starters. These should be on posters hanging on the wall near the sense-making circle. Revisit these as necessary during the discussion, especially if some students are dominating or avoiding the conversation.

When you form your circle, make sure there are no “double parkers,” that is, students positioned outside the circle standing behind others.

Your biggest role in the discussion is to ask, listen, and adjust. Ask your first planned question and listen to student responses and compare those to the what to listen for you planned for. Determine if students have provided a sufficient response, a partial response, such as one that does not contain evidence, or a response that is not accurate. Make a decision what to do next based on that response.

If students are on track, you might use a talk move such as “turn and talk with your partner, do you agree or disagree with the idea <student’s response>.

If the response is only partially developed, you might use a talk move such as “who can add more to what <student name> said?” or “what data do we have that supports <student’s response>.

If a particular student response is not accurate, you can use wait time to see if another student poses a question or adds to the conversation, ask a scaffolding question, or provide a sentence frame. Make adjustments in order to have all students engage with the question you asked.
These two pages show the connection between the sense-making planning guide and how this discussion might unfold in the classroom. Since each discussion will be different, this is provided as a sample.

### Sense-Making Discussion Planning Guide

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<thead>
<tr>
<th>Module</th>
<th>Energy</th>
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<td>Constructing explanations and using evidence to support an explanation.</td>
<td>Patterns; Cause and effect; Energy and matter</td>
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### Questions and What to Listen for

#### Steps 10–13: Have a sense-making discussion

**What to ask**
- As the starting position of the ball increases, what is the effect on the distance the cork moves? (Constructing explanations; cause and effect)
- What evidence do you have that supports this? What patterns do you notice that tells you this? (Constructing explanations; patterns)
- As the mass of the ball increases, what is the effect on the distance the cork moves? (Constructing explanations; cause and effect)
- What evidence do you have that supports this? What patterns do you notice that tells you this? (Constructing explanations; patterns)
- How was energy transferred in this system? (Constructing explanations; energy and matter)
- What two variables affect the energy of a ball rolling down a ramp? (Energy and matter)
- Which system had the most energy transfer? (Energy and matter)
- What evidence do you have that supports this? (Constructing explanations)

**What to listen for**
- The higher the starting point, the greater the distance the cork travels.
- The greater the mass, the greater the distance the cork travels.
- The kinetic energy of the ball is transferred to the cork by contact when they collide.
- The size (mass) of the ball and the position from which it starts rolling (its potential energy) are the two variables affecting energy of the ball.
- The largest ball starting at the highest position has the most kinetic energy.

**Scaffolding questions**
- When the large ball was released from a low position, how far did the cork move?
- When the large ball was released from a high position, how far did the cork move? Did it move a longer or shorter distance?
- How does the motion of the ball and the cork change during the collision?
- How are we measuring energy transfer in this system?

**Application questions**
- What could we change to increase the amount of energy transfer?
- How could we use this information to explain the effect on the pins when we are bowling?
- What does this tell us about how energy transfers during other collisions?
Conducting a Sense-Making Discussion

Decision Map—This is for an introductory sense-making discussion.

Content questions include data analysis, constructing explanations, and engaging in argumentation, using crosscutting concepts when appropriate.

**ASK**
- Ask content question.
- Listen and compare responses to “what to listen for.” What type of response was given?
- Ask additional question.

**LISTEN**
- Inaccurate analysis of data
  - Wait time
  - Agree/disagree and why with partner
  - Ask scaffolding question.
  - Provide sentence frame.
- On track conceptually; no evidence
  - Add on/say more
  - Ask for evidence.
  - Reference data in class notebook.
  - Provide claim-and-evidence frame.
- Sufficient from many students
  - Clarify answer with partner.

**ADJUST**
- Was all content discussed by all students?
  - No
  - Yes
  - End discussion and have students answer focus question individually.

**Scaffolding**
- Ask scaffolding question.
- Provide sentence frame.

**Talk moves**
- Question
- Decision
- Student action
- Talk move
- Instructional strategy

COLOR KEY
- Question
- Decision
- Student action
- Talk move
- Instructional strategy

Decision Map—This is for an introductory sense-making discussion.

Sense-Making Discussions for Three-Dimensional Learning—Grade 4
Before asking the next question on the list, decide what other ideas on the What to Listen For list came forward. If so, revisit the idea by saying something like, “An idea that [student’s name] mentioned was [student’s idea]” before asking the related question. This places value on student ideas and makes the conversation appear more student centered.

Continue asking your planned questions, listening and comparing to the what to listen for, and adjusting as needed until all the ideas come forward. Before moving on to the application questions, have students discuss the focus question. As time and student attention permits, ask the planned application questions following a similar sequence of ask, listen, and adjust. Application questions can be asked in a separate discussion as a wrap-up after students answer the focus question or at the start of the next lesson as a warm-up.

**After the Discussion**

After a sense-making discussion, you want students to write about their new knowledge in their science notebooks. After they answer the focus question in their notebooks, you can review their responses for embedded assessment. See the Assessment chapter for more information on embedded assessment. It’s ok to let some incomplete ideas or student questions linger when you know that the next lesson will continue to address those ideas. Resist resorting to telling students the answer as this rarely results in students adjusting their conceptual models. Instead, think of additional questions or experiences, such as engaging in argument, to address areas that warrant further consideration.

Last, and most important, have fun! Enjoy the intellectual struggle. This is the part where you never know what ideas students may trot out. Some discussions will be rich and rewarding, and others might not go so well, but it’s important to reflect on your practice and make incremental adjustments as needed to keep students striving to understand.
SENSE-MAKING SAMPLES—GRADE 4

On the next ten pages are samples of sense-making discussion planning guides from the three grade 4 FOSS Next Generation Modules—Soils, Rocks, and Landforms, Energy, and Environments. As you read the Investigations Guide to prepare for instruction, you will see a teaching note in the sidebar with red text, which tells you to refer to this chapter to find the sense-making sample for the specific investigation and part. The red-text teaching notes are found in the copyright 2018 FOSS Investigations Guide which is available to registered users on FOSSweb.

These are offered as samples, and should be customized to meet the needs of your students. As you become proficient facilitating sense-making discussions, you can use the template to create new planning guides for other discussions. A blank template of the Sense-Making Discussion Planning Guide can also be downloaded from FOSSweb.
### Sense-Making Discussions for Three-Dimensional Learning

**SENSE-MAKING DISCUSSION PLANNING GUIDE**

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<tr>
<td>Earth materials and systems (ESS2.A)</td>
<td><strong>Analyzing and interpreting data</strong> to make sense of phenomena. <strong>Constructing explanations</strong> and using evidence to support an explanation.</td>
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<td><strong>Step 14:</strong> Have a sense-making discussion</td>
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**What to ask**

- Do all vials contain the same amount of soil? *(Analyzing and interpreting data)*
- Do all vials have the same number of layers? *(Analyzing and interpreting data; patterns)*
- Are the layers the same thickness for each type of earth materials? *(Analyzing and interpreting data; patterns)*
- Can you identify each layer? *(Constructing explanations; patterns)*
- How are our schoolyard soils alike and different from the mountains, desert, river delta, and forest soils? *(Constructing explanations; patterns)*

**What to listen for**

- The amount of soil is similar.
- Different vials might have the same number of layers, but not always.
- The layers in the soil will vary if taken from different locations.
- Sand, silt and clay, and humus are likely to be identified; gravel and pebbles might also be present.
- The schoolyard soil is made up of different materials, just like soils from other locations. The amount of each layer will be different for each location.

**Scaffolding questions**

- What are the layers we found when we observe soil earlier?
- What do you think would be the biggest layer in the mountains? Why? the desert? the river delta? forest?

**Application questions**

- If we were to dig up soil in (provide a known location), what would you expect to find?
- Why do soils from different places have different amounts of earth materials?
- What does this tell you about how soil is formed?
**SENSE-MAKING DISCUSSION PLANNING GUIDE**

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<tr>
<td><strong>Guiding question:</strong></td>
<td>How do maps help us observe Earth's surface features?</td>
</tr>
<tr>
<td><strong>Focus question:</strong></td>
<td>How can we draw the profile of a mountain from a topographical map?</td>
</tr>
</tbody>
</table>

### NEXT GENERATION SCIENCE STANDARDS

<table>
<thead>
<tr>
<th>Focus DCI(s)</th>
<th>Focus SEP(s)</th>
<th>Focus CCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate tectonics and large-scale system interactions (ESS2.B)</td>
<td>Develop models to describe phenomena. Analyzing and interpreting data to make sense of phenomena.</td>
<td>Scale, proportion, and quantity</td>
</tr>
</tbody>
</table>

### Questions and What to Listen for

**Step 8: Have a sense-making discussion**

**What to ask**

- What is the contour interval for the topographic map you drew? [500 feet] (Analyzing and interpreting data)
- Is it the same for the USGS topographic map? [No, it is 40 feet.] (Analyzing and interpreting data; scale proportion, and quantity)
- Why do you think maps use different contour intervals? (Developing and using models; scale proportion, and quantity)
- Which side of the mountain shown on the Profile sheet is steeper? [B] How could you tell by just looking at the topographic map? (Developing and using models; scale proportion, and quantity)
- What do the contour lines on the A (or left) side of the map tell you about the slope of the mountain? (Analyzing and interpreting data; scale proportion, and quantity)
- Which side of the mountain would you want to walk up and why? (Developing and using models; scale proportion, and quantity)
- Why might people involved in outdoor activities use topographic maps and mountain profiles? (Developing and using models; scale proportion, and quantity)
- Why might scientists use topographic maps and mountain profiles? (Developing and using models; scale proportion, and quantity)
- How can we draw the profile of a mountain from a topographical map? (Developing and using models; scale proportion, and quantity)

**What to listen for**

- Depending on change in the landscape and the area covered by the map, different contour intervals are necessary. If the land is relatively flat, a smaller contour interval is more useful.
- The closer the contour lines, the steeper the mountain.
- People use maps and profiles to help them understand the land.

**Scaffolding questions**

- Why is it helpful to know if a mountain is steep?

**Application question**

- Our mountain profiles are models. What are the strengths and limitations of these models?
- How do maps help us study the surface of Earth?
### Sense-Making Discussions for Three-Dimensional Learning

#### SENSE-MAKING DISCUSSION PLANNING GUIDE

<table>
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<tr>
<th>Module</th>
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<tr>
<td><strong>Investigation 3:</strong></td>
<td>Mapping Earth’s Surface, <strong>Part 3:</strong> Mount St. Helens Case Study</td>
</tr>
<tr>
<td><strong>Guiding question:</strong></td>
<td>How do maps help us observe Earth’s surface features?</td>
</tr>
<tr>
<td><strong>Focus question:</strong></td>
<td>How can scientists and engineers help reduce the impacts that events like volcanic eruptions might have on people?</td>
</tr>
</tbody>
</table>

#### NEXT GENERATION SCIENCE STANDARDS

| Natural hazards (ESS3.B), developing possible solutions (ETS1.B) | Analyzing and interpreting data to make sense of phenomena. **Constructing explanations** and using evidence to support an explanation. | Stability and change |

#### Questions and What to Listen for

**Step 12:** Have a sense-making discussion

**What to ask**

- Why was Mount St. Helens an important event for scientists and engineers? (Analyzing and interpreting data, constructing explanations; stability and change)
- What did the scientists do before and after the eruption? (Analyzing and interpreting data, constructing explanations; stability and change)
- Why is it important for scientists to monitor changes? (Analyzing and interpreting data, constructing explanations; stability and change)
- Discussing ideas to reduce impacts
  - How will your idea help humans? (Constructing explanations; stability and change)
  - What changes will your idea reduce? (Constructing explanations; stability and change)

**What to listen for**

- Scientists and engineers were able to study how the eruption changed the landscape and environment.
- The equipment used to observe and monitor changes in volcanoes can help make predictions which can reduce the impact of eruptions.

**Scaffolding questions**

- What did Mount St. Helens look like before the eruption? after?
- What happened to the earth material that was inside the volcano?

**Application questions**

- What could scientists do to help others understand the impact of volcanoes?
### Module
Energy

**Investigation 2:** The Force of Magnetism, **Part 2:** Magnetic Fields

**Guiding question:** What affects magnetic force?

**Focus questions:** What happens when a piece of iron comes close to or touches a permanent magnet?

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<th>NEXT GENERATION SCIENCE STANDARDS</th>
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<tbody>
<tr>
<td>Focus DCI(s)</td>
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<tr>
<td>Types of interactions (PS2.B)</td>
</tr>
</tbody>
</table>

#### Questions and What to Listen for

**Steps 15-20:** Facilitate sense-making with two demonstrations

<table>
<thead>
<tr>
<th>What to ask</th>
<th>First demonstration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What forces are acting on the paper clip? (Analyzing and interpreting data; cause and effect)</td>
</tr>
<tr>
<td></td>
<td>What happens to the paper clip when it is in the magnetic field of the permanent magnet? (Analyzing and interpreting data; cause and effect)</td>
</tr>
<tr>
<td></td>
<td>What causes the paper clip to float in air? (Constructing explanations; cause and effect)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second demonstration</th>
</tr>
</thead>
<tbody>
<tr>
<td>What happens to the steel nail when it is in the magnetic field of the permanent magnet? (Analyzing and interpreting data; cause and effect)</td>
</tr>
<tr>
<td>If the steel nail is a magnet, where are the north and south poles? (Analyzing and interpreting data; cause and effect)</td>
</tr>
<tr>
<td>When the permanent magnet is turned upside down, what is the effect on the poles of the steel nail? (Constructing explanations; cause and effect)</td>
</tr>
<tr>
<td>What is the effect of the poles on the steel nails reversing? (Constructing explanations; cause and effect)</td>
</tr>
</tbody>
</table>

| What to listen for | • The force of magnetism attracts the paper clip on a string. The force of magnetism is stronger than the force of gravity pulling the paper clip down. |
|                   | • There is a magnetic field around the magnet. The magnetic field works through air. |
|                   | • Magnets make objects like the nail and paper clip temporary magnets. |
|                   | • Magnets have a north and south pole. Similar poles repel, opposite poles attract. |

<table>
<thead>
<tr>
<th>Scaffolding questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which direction is gravity pulling the paper clip? the string? the magnet?</td>
</tr>
<tr>
<td>What was the rule we had for when magnets attract and repel?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you think will happen if we cut the string off the paper clip?</td>
</tr>
<tr>
<td>What would happen if we used two magnets on the chair instead of one?</td>
</tr>
</tbody>
</table>
Sense-Making Discussions for Three-Dimensional Learning

SENSE-MAKING DISCUSSION PLANNING GUIDE

Module

Investigation 3: Electromagnets, Part 1: Building an Electromagnet

Guiding question: What causes electromagnetism and how can we use it to transfer energy?

Focus question: How can you turn a steel rivet into a magnet that turns on and off?

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<tbody>
<tr>
<td>Types of interactions (PS2.B) Conservation of energy and energy transfer (PS3.B)</td>
<td>Constructing explanations and using evidence to support an explanation.</td>
<td>Cause and effect Systems and system models Energy and matter</td>
</tr>
</tbody>
</table>

Questions and What to Listen for

Steps 13, 14: Review the functions of the components

What to ask

- What is the function of the D-cell? (Analyzing and interpreting data; systems and system models)
- What is the function of the wire? (Analyzing and interpreting data; systems and system models)
- What is the function of the core (steel rivet)? (Analyzing and interpreting data; systems and system models)
- Is electricity flowing into the core? Why or why not? (Constructing explanations; energy and matter)
- What is the effect on the core if the magnetism is being produced by all those wraps of wires? (Constructing explanations; cause and effect)
- What evidence do we have that energy is transferred when using an electromagnet? (Constructing explanations; energy and matter)

What to listen for

- The D-cell is the source of energy, wire is to conduct electricity only where needed. The core because a temporary or induced magnet.
- Electricity doesn’t flow into the core because the wire is insulated. The magnetic field does go through the insulation.
- The core become a temporary magnet because it is in the magnetic field of the flowing electricity.
- The movement of the small washers transfers energy and the heat of the D-cell are evidence of energy transfer.

Scaffolding questions

- What happens when electricity flows? What happened to the compass when we placed it on top of the wire?

Application questions

- What would happen if we wrapped the core with more winds?
- What would happen if we used a wood core instead of a steel core?
SENSE-MAKING DISCUSSION PLANNING GUIDE

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<td><strong>Investigation 4:</strong></td>
<td>Energy Transfer, Part 3: Collisions</td>
</tr>
<tr>
<td><strong>Guiding question:</strong></td>
<td>How does energy transfer between objects or systems?</td>
</tr>
<tr>
<td><strong>Focus question:</strong></td>
<td>What happens when objects collide?</td>
</tr>
</tbody>
</table>

### NEXT GENERATION SCIENCE STANDARDS

| Conversation of energy and energy transfer (PS3.B) | Constructing explanations and using evidence to support an explanation. | Patterns | Cause and effect | Energy and matter |

### Questions and What to Listen for

**Steps 10–13:** Have a sense-making discussion

#### What to ask

- As the starting position of the ball increases, what is the effect on the distance the cork moves? *(Constructing explanations; cause and effect)*
- What evidence do you have that supports this? What patterns do you notice that tells you this? *(Constructing explanations; patterns)*
- As the mass of the ball increases, what is the effect on the distance the cork moves? *(Constructing explanations; cause and effect)*
- What evidence do you have that supports this? What patterns do you notice that tells you this? *(Constructing explanations; patterns)*
- How was energy transferred in this system? *(Constructing explanations; energy and matter)*
- What two variables affect the energy of a ball rolling down a ramp? *(Energy and matter)*
- Which system had the most energy transfer? *(Energy and matter)*
- What evidence do you have that supports this? *(Constructing explanations)*

#### What to listen for

- The higher the starting point, the greater the distance the cork travels.
- The greater the mass, the greater the distance the cork travels.
- The kinetic energy of the ball is transferred to the cork by contact when they collide.
- The size (mass) of the ball and the position from which it starts rolling (its potential energy) are the two variables affecting energy of the ball.
- The largest ball starting at the highest position has the most kinetic energy.

#### Scaffolding questions

- When the large ball was released from a low position, how far did the cork move?
- When the large ball was released from a high position, how far did the cork move? Did it move a longer or shorter distance?
- How does the motion of the ball and the cork change during the collision?
- How are we measuring energy transfer in this system?

#### Application questions

- What could we change to increase the amount of energy transfer?
- How could we use this information to explain the effect on the pins when we are bowling?
- What does this tell us about how energy transfers during other collisions?
### SENSE-MAKING DISCUSSION PLANNING GUIDE

**Module:** Environments  
**Investigation 2:** Ecosystems, **Part 3:** Population Simulation  
**Guiding question:** How do organisms sense and interact with their environment?  
**Focus question:** How does food affect a population in its home range?

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<th>Focus CCs</th>
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</thead>
<tbody>
<tr>
<td>Ecosystem dynamics, functioning, and resilience (LS2.C)</td>
<td>Developing and using models to test cause-and-effect relationships.</td>
<td>Systems and system models</td>
</tr>
<tr>
<td></td>
<td>Constructing explanations and using evidence to support an explanation.</td>
<td>Stability and change</td>
</tr>
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</table>

#### Questions and What to Listen for

**Step 17:** Have a sense-making discussion

**What to ask**

- Which year was the easiest for each of your deer to survive? (Analyzing and interpreting data)
- Can we say in what year the number of deer reached carrying capacity for the home range? How do we know? (Analyzing and interpreting data; systems and system models)
- In this simulation, which factors determined the carrying capacity of the home range? (Analyzing and interpreting data; systems and system models)
- What happens to the deer populations when they exceed the carrying capacity? (Developing and using models, constructing explanations; stability and change)
- What happens to the deer population when the size doesn’t exceed the carrying capacity? (Developing and using models, constructing explanations; stability and change)
- How does this model help us understand what might happen to populations of other organisms, such as mealworms or fish? (Developing and using models, constructing explanations; systems and system models, stability and change)

**What to listen for**

- Deer survive easily in year 1 because there is plenty of food. In year 4, there was limited food.
- The deer reached carrying capacity in year 3 because they caused damage to the food source.
- The amount of food and size of the population determine the carrying capacity in this model. When the deer exceed the carrying capacity, the some deer move to new locations, others die.
- Populations of animals cannot eat all the food in a location because they will die or have to move to another location.

**Scaffolding questions**

- What year had the deer population decreased? What caused the change?
- What happens to the amount of food available when the deer eat all of it the previous year?

**Application questions**

- How does the food affect the deer population?
- What happens when there are too many deer and limited food?
- What would happen to the carrying capacity if the amount of food increases?
**Module**

Environments

**Investigation 2:** Ecosystems, Part 4: Sound Off

**Guiding question:** How do organisms sense and interact with their environment?

**Focus question:** How do animals use their sense of hearing?

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Information processing (LS1.D)</td>
<td>Planning and carrying out investigations by making observations. Constructing explanations and using evidence to support an explanation.</td>
<td>Cause and effect</td>
</tr>
</tbody>
</table>

### Questions and What to Listen for

#### Step 10: Have a sense-making discussion

**What to ask**

- What was it like to have restricted vision and to depend on your sense of hearing to find a partner? (Planning and carrying out investigations, analyzing and interpreting data)
- What happened to prey who made lots of noise all the time? (Planning and carrying out investigations, analyzing and interpreting data; cause and effect)
- Which noisemakers attracted the most attention? (Planning and carrying out investigations, analyzing and interpreting data; cause and effect)
- What listening techniques worked best to locate a partner? (Analyzing and interpreting data; cause and effect)
- Was it easy or hard to walk toward a partner’s sound? Why? (Constructing explanations; cause and effect)
- Did any other noises in the environment make the activity more challenging? As prey? As predator? (Constructing explanations; cause and effect)
- How does this simulation help you understand how animals use their sense of hearing? (Constructing explanations; cause and effect)

**What to listen for**

- If prey are noisy, they are easy to find. Some noisemakers are louder than others.
- Techniques such as staying still are helpful in locating the direction of the sound.
- Some noises from birds distract or interfere with hearing the prey or predators.
- Animals can locate prey when they might not be able to see them, such as at night or in a cave. Prey can avoid noisy predators.

**Scaffolding questions**

- Was it easy to hear the prey when you were moving as a predator?
- What information did the cowbell noise send to the prey?

**Application questions**

- What would happen if all of the prey made the same noise? Could you find your group?
- How does having a unique sound help animals? How could it be harmful?
- What does this investigation tell you about how animals interact with their environment?
### Module
Environments

**Investigation 3:** Brine Shrimp Hatching, Part 3: Determining Viability

**Guiding question:** How is optimum environment related to organism and population survival?

**Focus question:** Does changing the salt environment allow the brine shrimp eggs to hatch?

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<tbody>
<tr>
<td>Structure and function (LS1.A), Ecosystem dynamics, functioning, and resilience (LS2.C)</td>
<td>Constructing explanations and using evidence to support an explanation.</td>
<td>Cause and effect</td>
</tr>
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</table>

### Questions and What to Listen for

**Step 9:** Have a sense-making discussion

#### What to ask

- How do organisms respond when they are in an environment that is not in their range of tolerance? (Analyzing and interpreting data; cause and effect)
- What do beetles and isopods do when they aren’t in their preferred environment? (Analyzing and interpreting data; cause and effect)
- How is this similar to the hatching of brine shrimp eggs? (Constructing explanations; cause and effect)
- What other environmental conditions do brine shrimp need to be in their range of tolerance? (Constructing explanations; cause and effect)

#### What to listen for

- If the environment is not in their range of tolerance, they can move, die, or wait until the conditions change before hatching.
- Beetles and isopods move to their preferred environment.
- Brine shrimp eggs can't move, so they wait until the conditions change. In both cases, they don't live in a location outside of their range of tolerance (for too long).
- Most organisms have ranges of tolerance for multiple environmental factors, such as food, temperature, light, and air.

#### Scaffolding questions

- What did the brine shrimp eggs do when they were in their range of tolerance?
- What would you do if the environment was too cold for you?
- We tested the brine shrimp range of tolerance for salt. Brine shrimp need salt water, what other needs do brine shrimp have? Do you think they have a range of tolerance for the amount of food or temperature of water?

#### Application questions

- What are other examples of how animals respond to conditions outside of their range of tolerance?
- If an organism lives in their optimum environment, what do you think will happen to the population of that organism?
Module: Environments

Investigation 4: Range of Tolerance, Part 1: Water or Salt Tolerance and Plants

Guiding question: What environmental conditions result in the best growth and survival of different plants?

Focus question: How much water is needed for early growth of different kinds of plants? What is the salt tolerance of several common farm crops?

NEXT GENERATION SCIENCE STANDARDS

<table>
<thead>
<tr>
<th>Focus DCI(s)</th>
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<tbody>
<tr>
<td>Structure and function (LS1.A), Biodiversity and humans (LS4.D)</td>
<td>Constructing explanations and using evidence to support an explanation.</td>
<td>Cause and effect</td>
</tr>
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Questions and What to Listen for

Step 40: Have a sense-making discussion

What to ask

Water experiment
- What is the least amount of water needed to grow these plants? Is the least amount the same for all kinds of plants? (Analyzing and interpreting data)
- Can you give plants too much water? What happens to the plants? (Analyzing and interpreting data; cause and effect)
- What is the range of water in which your kind of plant survived? (Analyzing and interpreting data; constructing explanations; cause and effect)
- Which water environment was best for each kind of plant? (Analyzing and interpreting data; constructing explanations; cause and effect)

Salt experiment
- Did the seeds germinate the same in all salt concentrations? What do you think caused this? (Analyzing and interpreting data; cause and effect)
- Did plants grow to the same height in all salt concentrations? What do you think caused this? (Analyzing and interpreting data; cause and effect)
- Did the same number of plants grow in all salt concentrations? What do you think caused this? (Analyzing and interpreting data; cause and effect)
- How does salt affect each kind of plant? (Constructing explanations; cause and effect)

What to listen for

- Plants need water in order to germinate. None will grow in the dry environment. There might be some growth initially in the moist swamp, but they often die later.
- The seeds will thrive in wet and some in very wet, data from the plant profile is used as evidence to support explanations.
- Barley and corn are usually more salt tolerant than peas and radishes.
- Salt negatively affects these four plants. They are smaller and fewer in number than the same plants grown without salt.

Scaffolding questions

- How many plants grew in <environmental condition> How tall are they?
- If a plant grows taller in one environment, what does that tell you about their preferred environment?

Application questions

- How is this experiment similar to the mealworm experiment? the isopods? the brine shrimp?
- Which crop would you grow in salty conditions?