INTRODUCTION—GRADE 5

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 made three different mixtures, gravel and water, powder and water, and salt and water. They observed the mixtures and used tools, a screen and filter paper, to separate the mixtures. 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 which of the tools were able to separate which mixtures.

Students turn and talk to a partner while another pair of students add their observations to the class notebook. A few students share that the screen was able to separate the gravel from the water and that the filter paper separated the powder from the water. 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 some materials pass through the screen but others do not. Ideas about the size of the pieces and the size of the holes in the screen and filter paper are compared and drawn in the class notebook. These are 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 size of the particles in the mixtures. 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 5 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 5 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, science and engineering practices, and crosscutting concepts, 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.

INVESTIGATION 1 – Separating Mixtures

BACKGROUND for the Teacher

The anchor phenomenon investigated in this module is matter (as the form of samples of solid substances) and its interactions with water. The driving question is what happens when samples of matter interact?

In Investigation 1, students investigate the phenomena of simple mixtures, suspensions, and solutions made with water. The guiding question is what happens when two or more samples of materials are combined?

We've all had experience with mixtures of one kind or another: a handful of coarse grains of different denominations, a can of mixed nuts, or a mixed bag of treats. Separating mixtures is also a familiar experience: sorting the dimes out of change, picking the cashews out of the nut mix, or organizing the different kinds of treats in a bag you buy at the store.

How Can a Mixture Be Separated?

Any time two or more materials with different properties are dispersed fairly uniformly throughout one another, they constitute a mixture.

“Any time two or more substances with different properties are dispersed fairly uniformly throughout one another, they constitute a mixture.”

Solids, liquids, and gases can be mixtures. Mixtures can be phase specific. A handful of sand and gravel is a mixture of solids, a cupcake of magarette salad dressing is a mixture of liquids and oils, and a can of atmospheric gases. Most mixtures, however, are phase inclusive. Milk is a mixture of solids (proteins, sugar, and fat) and liquid (water), a bag of party mix is a mixture of solids and gases, a bowl of meringue is a mixture of liquids and gases, and a root-beer float is a mixture of solids, liquids, and gases.

Mixtures can be separated into their component parts. Some are easy, such as sorting a collection of nuts and bolts manually by size. Other properties allow us to use a magnet to separate a mixture of paper, steel, and potato chips. Corks can be separated from pennies by dumping the mixture into water. Screens are useful for separating mixtures of solids of different sizes or mixtures of solids and liquids.

Sometimes when a solid and a liquid mix, the solid dissolves, or dissolves, in the liquid. When a solid dissolves, it breaks into tiny parts that disperse uniformly and freely throughout the liquid. The resulting mixture is a solution. Solvents are mixtures of two or more materials—a solvent (usually a liquid) and a solute (usually a solid). A solute dissolves as a solute to form a solution.

In the case of solutions made with water (aqueous solutions), the solution will be transparent. (Students will only be making aqueous solutions in this module, but we will not be using the term aqueous with students, just...
Exposing Crosscutting Concepts (CC)

The third dimension of instruction involves the crosscutting concepts, sometimes referred to as the unifying principles, themes, or big ideas, that are fundamental to the understanding of science and engineering.

These concepts should become common and familiar touchstones across the discipline and grade levels. Explicit reference to the concepts, as well as their emergence in multiple disciplinary contexts, can help students develop a cumulative, coherent, and scalable understanding of science and engineering. (National Research Council 2012, page 83)

In this first investigation, the focus is on these crosscutting concepts.

• Cause and effect: Cause-and-effect relationships between solids and liquids can be used to explain mixtures and solutions.
• Scale, proportion, and quantity: Standard units of mass and volume are needed to understand the process of dissolving.
• Systems and system models: A mixture can be studied in terms of its component parts and their interactions.

Connections to the Nature of Science

• Scientific investigations use a variety of methods. Scientific methods are determined by questions. Scientific investigations use a variety of methods, tools, and techniques. Scientific investigations use a variety of methods, tools, and techniques.

Connections to Engineering, Technology, and Applications of Science

• Influence of science, engineering, and technology on society and the natural world: Engineers improve existing technologies or develop new ones. Over time, people’s needs and wants change, as do their demands for new and improved technologies. When new technologies become available, they can bring about changes in the way people live and interact with one another.

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Plan 1—Separating Mixtures

BACKGROUND for the Teacher
The anchor phenomenon investigated in this module is matter (in the form of samples of solid substances) and its interactions with water. The driving question for the module is what is matter and what happens when samples of matter interact?

In Investigation 1, students investigate the phenomena of simple mixtures, suspensions, and solutions made with water. The guiding question is: what happens when two or more samples of matter are combined?

How Can a Mixture Be Separated?
Any time two or more materials with different properties are dispersed fairly uniformly throughout one another, they constitute a mixture. Solids, liquids, and gases can form mixtures. Mixtures can be phase specific. A handful of sand and gravel is a mixture of solids, a cackle of invertebrate salad is a mixture of liquids, or air is a mixture of atmospheric gases. Most mixtures, however, are phase inclusive. Milk is a mixture of solids (proteins, sugars, and fats) and liquid (water); a bag of party mix is a mixture of solids and gases; a bowl of meringue is a mixture of solids, liquid, and gases.

Mixtures can be separated into their component parts. Some are easy, such as sorting a collection of nuts and bolts manually by size. Other properties allow us to use a magnet to separate a mixture of paper clips and glass beads. Corks can be separated from pennies by dumping the mixture into water. Screens are useful for separating mixtures of solids dispersed fairly uniformly through a liquid. A sieve is a sieve to separate a solid from a solution. In the case of solutions made with water (aqueous solutions), the solute should be transparent. Students will only be making aqueous solutions in this module, but we will not be using the term aqueous with students.

Solvent
The solution is identified as an extract that a small amount of organic material dissolved in the water. The color change is evidence that a small amount of organic material dissolved in the water. They mix leaves, bark, berries, soil, etc., with water. There is no observable evidence that the materials dissolve, but the water changes. The color change is evidence that a small amount of organic material dissolved in the water.

Evaporate

Filter

Separate

Evaporate

Engineers plan designs, select materials, construct products, implement analysis, and improve ideas.

Engineers use people who...design products or plans for making things. They then attempt to separate the three mixtures. They find that different methods are effective for separating mixtures with different properties. A screen separates gravel and water; a filter separates powder and water. The salt presents a problem because it dissolves, producing a solution. The salt is separated from the water with evaporation and appears as crystals.

In Part 2, students investigate what happens to the salt when it dissolves. They determine the mass of water and the mass of the solution after salt is added. Applying the concept that mass is conserved, they determine that the salt is present but invisible in a solution.

In Part 3, students tackle an application problem—separate a mixture of four materials. They first attempt to separate the mystery material. Students discover that the mystery material (magnets) can be separated using a magnet. Students are next to engineer a separation procedure that is effective and efficient. Students review the elements of engineering design as they apply their knowledge to design an efficient system to separate a mixture and discuss their efforts in terms of science and engineering practices.

In Part 4, students look for materials in the schoolyard that dissolve in water. They mix leaves, bark, berries, soil, etc., with water. There is no observable evidence that the materials dissolve, but the water changes. The color change is evidence that a small amount of organic material dissolved in the water. The solution is identified as an extract.

Teaching Children about Mixtures and Solutions
Conceptual Flow
The anchor phenomenon investigated in this module is matter (in the form of samples of solid substances) and its interactions with water. The guiding question is what is matter and what happens when samples of matter interact?

In Investigation 1, students investigate the phenomena of simple mixtures, suspensions, and solutions made with water. The driving question for the module is what is matter and what happens when samples of matter interact?

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.
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 5, plan about 12-15 minutes for the sense-making discussion.

To illustrate this process we will use an example from the Mixtures and Solutions Module, Investigation 1, Separating Mixtures, Part 1: Making and Separating Mixtures. 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 questions that will guide students toward the desired understandings (DCIs).

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14. Have a sense-making discussion

After the powder-and-salt mixtures have been filtered, ask students to carefully open up the two filter papers and spread them flat on a paper towel on the table. Ask,

➤ Which mixtures were you able to separate with a filter? [Only the powder and water.]
➤ What caused the powder to separate from the water? [The holes in the filter paper were too small.]
➤ How are a screen and a paper filter similar? How are they different? [Both separate materials, but the paper filter has finer holes.]

15. Introduce solution

Have students discuss in their groups what they think happened to the salt. Record a few of their ideas on chart paper, then explain,

If a solid material is mixed with water, and the solid material disappears in the water, the mixture is a solution. Salt disappears, or dissolves, in water to make a saltwater solution.

When a solid material dissolves in water, the solution is transparent (clear), and it can’t be separated with a filter.

Write the new words on the word wall.

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NOTE
It is important that a sense-making discussion occur after data acquisition but before students are asked to answer the focus question. The discussion will prepare the students to answer the focus question.

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TEACHING NOTE
Refer to the Sense-Making Discussions for Three-Dimensional Learning chapter in Teacher Resources on FOSSweb for more information about how to facilitate this with students.
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 lungs?” or “What causes the Sun to appear to move across the sky?” 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
- Which mixtures were you able to separate with a filter?
- What caused the powder to separate from the water?
- How are a screen and a paper filter similar? How are they different?
- How can mixtures be separated?

What to listen for
- The filter separates the powder from the water.
- The holes in the filter paper were too small to let the powder through but the water could go through.
- Both separate materials, but the paper filter has finer (or smaller) holes.
- Some mixtures can be separated by using a screen or a filter.
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 sand heats up faster than water when placed in the sunlight. What does that tell you about how the Sun heats the land compared to the ocean?” or “Jenny said the more concentrated a solution is, the heavier it is. Do you think this is true for all solutions? 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 the 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 Engineering Practices and Crosscutting Concept chapters. The next-step strategies found in the Assessment and Science Notebooks 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: Mixtures and Solutions

Investigation 1: Separating Mixtures, Part 1: Making and Separating Mixtures

Guiding question: What happens when two or more samples of materials are combined?

Focus question: How can mixtures be separated?

NEXT GENERATION SCIENCE STANDARDS

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<td>Plan and carry out investigations by making observations to produce data.</td>
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<tr>
<td>Cause and effect</td>
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Questions and What to Listen For

Step 14: Have a sense-making discussion

What to ask

- Which mixtures were you able to separate with a filter? (Planning and carrying out investigations)
- What caused the powder to separate from the water? (Analyzing and interpreting data; cause and effect)
- How are a screen and a paper filter similar? How are they different? (Analyzing and interpreting data; patterns)
- How can mixtures be separated? (Planning and carrying out investigations; cause and effect)

What to listen for

- The filter separates the powder from the water.
- The holes in the filter paper were too small to let the powder through but the water could go through.
- Both separate materials, but the paper filter has finer (or smaller) holes.
- Some mixtures can be separated by using a screen or a filter.

Scaffolding questions

- How do the holes in the screen compare to the holes in the filter paper?
- How does the size of the gravel compare to the size of the powder?

Application questions

- Sand is smaller than gravel, but larger than the powder. What could you do to cause the sand to separate from a sand and water mixture?
- Why is the size of a material an important property when separating some mixtures?
- What other mixtures could you separate with a screen?

These are questions that help students process the data to extract meaning.

These are the intended responses to the content questions. As these ideas come forward, talk moves are used to engage all students.

These are questions to ask if students need guidance when processing data and the intended responses are not being heard.

These questions are designed to extend knowledge beyond the discreet experience for the lesson.
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 go.

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**My Responsibilities**

I agree that I will:
- explain my ideas,
- listen to others and show that I am listening,
- ask questions when I am confused or can’t hear,
- connect my ideas to others’ (explain, add to, respectfully disagree),
- participate because all ideas lead to learning (speak loud and clear).

---

**Respond to other ideas**

Can you explain to me...?
Why do you think...
What evidence do you have...
Are you saying...
agree with...
respectfully disagree with...

---

**When scientists share their own ideas, they may say...**
- I observed...
- I noticed...
- My data show...
- I think... because...
- I wonder...

---
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.

**NOTE**

The next 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.
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**Questions and What to Listen For**

**Step 14:** Have a sense-making discussion

**What to ask**
- Which mixtures were you able to separate with a filter? (Planning and carrying out investigations)
- What caused the powder to separate from the water? (Analyzing and interpreting data; cause and effect)
- How are a screen and a paper filter similar? How are they different? (Analyzing and interpreting data; patterns)
- How can mixtures be separated? (Planning and carrying out investigations; cause and effect)

**What to listen for**
- The filter separates the powder from the water.
- The holes in the filter paper were too small to let the powder through but the water could go through.
- Both separate materials, but the paper filter has finer (or smaller) holes.
- Some mixtures can be separated by using a screen or a filter.

**Scaffolding questions**
- How do the holes in the screen compare to the holes in the filter paper?
- How does the size of the gravel compare to the size of the powder?

**Application questions**
- Sand is smaller than gravel, but larger than the powder. What could you do to cause the sand to separate from a sand and water mixture?
- Why is the size of a material an important property when separating some mixtures?
- What other mixtures could you separate with a screen?
Content questions include data analysis, constructing explanations, and engaging in argumentation, using crosscutting concepts when appropriate.

**COLOR KEY**

- **ASK**
  - Ask content question.
  - Ask additional question.

- **LISTEN**
  - Inaccurate analysis of data
  - On track conceptually; no evidence
  - Sufficient from many students

- **TALK move**
  - Wait time
  - Add on/say more
  - Ask for evidence.
  - Clarify answer with partner.

- **Scaffolding**
  - Ask scaffolding question.
  - Reference data in class notebook.
  - Provide claim-and-evidence frame.

- **ADJUST**
  - Agree/disagree and why with partner
  - Ask for evidence.
  - Reference data in class notebook.
  - Provide claim-and-evidence frame.

- **Student action**
  - End discussion and have students answer focus question individually.

**Decision Map**—This is for an introductory sense-making discussion.
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 5

On the next ten pages are samples of sense-making discussion planning guides from the three grade 5 FOSS Next Generation Modules—Earth and Sun, Mixtures and Solutions, and Living Systems. 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 latest 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.
## Module
Earth and Sun

### Investigation 1: The Sun, Part 3: Day and Night

**Guiding question:** What do shadows tell us about daily patterns involving the Earth/Sun system?

**Focus question:** What causes day and night?

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<tr>
<td>Earth and the solar system (ESS1.B)</td>
<td>Construct an explanation of observed relationships.</td>
<td>Cause and effect Systems and system models</td>
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### Questions and What to Listen For

**Step 18:** Have a sense-making discussion

**What to ask**
- *Why is it dark at night?* (Analyzing and interpreting data)
- *At any given time, how much of Earth is in day and how much is in night?* (Analyzing and interpreting data; patterns)
- *What makes the Sun appear to move across the sky?* (Constructing explanations; cause and effect, systems and system models)
- *What makes the Sun “rise” and “set”?* (Constructing explanations; cause and effect, systems and system models)
- *Does the Sun rise in the morning all over the world? Explain?* (Constructing explanations; systems and system models)

**What to listen for**
- The Sun is the source of light that illuminates the Earth’s surface.
- When light falls on an object, the object is illuminated, the area behind the object is in shadow.
- When light falls on a spherical object, half of the object is lit (day), the other half is in its own shadow (night).
- From our position on Earth, it looks as though the Sun circles Earth once every day, but in reality the Sun is stationary and Earth rotates on its axis once every day. That makes it look like the Sun rises and sets.
- One complete rotation of our planet describes one complete day. For Earth, one rotation requires 24 hours (1 day).

**Scaffolding questions**
- *What causes a shadow?*
- *How did you model the rotation of the Earth?*

**Application questions**
- *How did our modeling help you understand the Earth/Sun relationship?*
- *If Earth did not rotate on its axis, how would day and night be different?*
SENSE-MAKING DISCUSSION PLANNING GUIDE

Module | Earth and Sun

Investigation 2: Planetary Systems, Part 5: Stars

Guiding question: What do we see outside of our system?

Focus question: Why do stars appear to move across the night sky?

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<tr>
<td>The universe and its stars (ESS1.A), Earth and the solar system.</td>
<td>Develop models to describe phenomena. Construct an explanation of observed relationships.</td>
<td>Patterns Cause and effect System and system models</td>
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Questions and What to Listen For

Step 13: Have an Earth/Sun system sense-making discussion

What to ask

- Do we see stars (other than our Sun) during the daytime or the nighttime? (Constructing explanations; cause and effect)
- Which side of our summer Earth is in daylight? nighttime? (Analyzing and interpreting data; patterns)
- It is now winter on Earth. Can I see Aquila? (Analyzing and interpreting data; patterns)
- What stars will we see during the winter? spring, fall? (Developing and using models; patterns, cause and effect)
- Are these stars in our solar system? (Constructing explanations; patterns)
- Why is our Sun is so much brighter and looks so much bigger than these other stars? (Constructing explanations; patterns, cause and effect)
- Why do we see certain stars only during certain seasons? (Developing and using models, constructing explanations; patterns, cause and effect, systems and system models)

What to listen for

- The side of our summer Earth in daylight faces the light, the side in night is towards wall 1.
- Aquila isn’t visible during our winter Earth. The only stars visible to winter Earth are on wall 3. Spring Earth sees wall 4 and fall sees wall 2.
- The only star in our solar system is the Sun.
- The Sun is so much closer to Earth than the other stars.
- The direction that the dark side of Earth faces changes as Earth orbits the Sun. The seasons also change as Earth orbits the Sun.

Scaffolding questions

- If you had two flashlights, and one flashlight was very far away from you, the other right next to you, which would look bright when they were turned on?

Application questions

- Why do we see the constellation Orion only in the winter sky?
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<td><strong>Guiding question:</strong> How does Earth's atmosphere heat up?</td>
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<td><strong>Focus question:</strong> What happens when a volume of fluid is warmed at the bottom?</td>
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<td>Earth materials and systems (ESS2.A)</td>
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**Questions and What to Listen For**

**Step 27:** Have a sense-making discussion

**What to ask**

- How are convection currents produced in the air? *(Constructing explanations; cause and effect)*
- Explain what causes wind. *(Constructing explanations; cause and effect)*
- What happens to air particles when air is heated? *(Constructing explanations; cause and effect)*
- What is the source of energy that causes the wind to blow? *(Constructing explanations; cause and effect)*
- What is the connection between the experiment you did with the blue water and the convection current diagrams in the reading? *(Obtaining, evaluation, and communicating information, constructing explanations, engaging in argumentation from evidence)*

**What to listen for**

- Solar energy is unevenly absorbed by Earth's surface. Hot surfaces transfer energy to the air. Air molecules move fast and push farther apart. The air near Earth's surface becomes less dense. More-dense air over cooler surfaces flows toward the area with less-dense air. The less-dense air is pushed up. As it rises, the warm air cools, become more dense. The cool air falls back to Earth, completing a circular flow of air, a convection current.
- Wind is air that is flowing across Earth's surface as part of a convection current.
- When air particles are heated, they gain energy. They move faster and hit one another harder. The hard-hitting particles push air particles apart, and the air mass becomes less dense.
- Solar energy from the Sun is the source of energy that causes wind to blow.
- The experiment with the blue water and the convection current diagrams in the reading both show convection currents. The fluid in the experiment is water, in the diagram it is air. The experiment is rotated 90 degrees on its side.

**Scaffolding questions**

- What causes air to move?
- How does air become more dense? less dense?

**Application questions**

- How does the geosphere (land) and atmosphere interact?
## Sense-Making Discussion Planning Guide

### Module
- Mixtures and Solutions

### Investigation 1: Separating Mixtures, Part 1: Making and Separating Mixtures

### Guiding question:
What happens when two or more samples of materials are combined?

### Focus question:
How can mixtures be separated?

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<tr>
<td>Structure and properties of matter (PS1.A) Developing possible solutions (ETS1.B)</td>
<td>Plan and carry out investigations by making observations to produce data.</td>
<td>Cause and effect</td>
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### Questions and What to Listen For

**Step 14:** Have a sense-making discussion

### What to ask
- Which mixtures were you able to separate with a filter? (Planning and carrying out investigations)
- What caused the powder to separate from the water? (Analyzing and interpreting data; cause and effect)
- How are a screen and a paper filter similar? How are they different? (Analyzing and interpreting data; patterns)
- How can mixtures be separated? (Planning and carrying out investigations; cause and effect)

### What to listen for
- The filter separates the powder from the water.
- The holes in the filter paper were too small to let the powder through but the water could go through.
- Both separate materials, but the paper filter has finer (or smaller) holes.
- Some mixtures can be separated by using a screen or a filter.

### Scaffolding questions
- How do the holes in the screen compare to the holes in the filter paper?
- How does the size of the gravel compare to the size of the powder?

### Application questions
- Sand is smaller than gravel, but larger than the powder. What could you do to cause the sand to separate from a sand and water mixture? Why is the size of a material an important property when separating some mixtures?
- What other mixtures could you separate with a screen?
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<td>What is the relationship between salt-solution concentration and density?</td>
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<td>Structure and properties of matter (PS1.A)</td>
<td>Analyze and interpret data to describe phenomena.</td>
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### Questions and What to Listen For

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

**What to ask**

- Why did the plastic mass piece float in one cup of liquid and sink in another? (Analyzing and interpreting data; cause and effect)
- What does your data tell you about the density of the salt solutions? (Analyzing and interpreting data)
- Which solution is most dense? Which is least dense? (Analyzing and interpreting data)
- How can we compare the concentration of the red solution and the blue solutions? (Planning and carrying out investigations)
- Think back to your model about solvents and solutes, what does it mean when one solution is more concentrated than another? (Developing and using models; cause and effect)
- What is the relationship between salt-solutions concentration and density? (Constructing explanations; cause and effect)

**What to listen for**

- The mass piece floated in liquid A because the piece was less dense than the liquid. The piece sank in liquid B because it was more dense.
- If one solution sinks in another, it is more dense. If the solution floats, it is less dense.
- The blue solution is the most dense and the red solution is the least dense.
- If you compare equal volumes of each solution, the denser one will be the heaviest.
- When a solution is more concentrated, it means that more solute dissolved in the same amount of solvent.
- The greater the concentration, the more dense the solution.

**Scaffolding questions**

- What does it mean when one object or liquid sinks in another liquid?
- If one solution is more concentrated, will it weigh more or less than a less concentrated liquid?

**Application questions**

- How does the concentration of the yellow solution compare to the blue and red solution? How do you know?
- What could we do to make the red solution as concentrated as the blue solution? What would that do to the density of the red solution?
- How does knowing the concentration and density help us identify solutions?
### SENSE-MAKING DISCUSSION PLANNING GUIDE

**Module**  
Mixtures and Solutions

**Investigation 4: Reaching Saturation, Part 3: The Saturation Puzzle**

**Guiding question:** How can the property of solubility be used to identify a substance?

**Focus question:** What is the identity of the mystery substance?

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<td>Structures and properties of matter (PS1.A)</td>
<td>Constructing explanations using evidence.</td>
<td>Patterns</td>
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### Questions and What to Listen For

**Step 16:** Have a sense-making discussion

**What to ask**

- Why is solubility a useful property for us to know? (Analyzing and interpreting data)
- How can the property of solubility be used to identify a substance? (Analyzing and interpreting data; patterns)
- Which solutions could the mystery substance be? (Analyzing and interpreting data; patterns)
- Why is it important for scientists to have more than one piece of evidence? (Constructing explanations)
- Why is the crystal structure another useful property to identify a solution? (Constructing explanations; patterns)
- What properties are the same for all the possible mystery substances? What properties are different? (Constructing explanations; patterns)

**What to listen for**

- Solubility helps identify substances. Different substances have different solubilities.
- A substance can be added to a known volume of water until no more solid will dissolve. The undissolved solid can be filtered out. The solution can then be weighed and the mass of the dissolved solid can be determined.
- Having more than one piece of evidence strengthens the explanation.
- Substances have a crystal form. Unknown substances can be dissolved and the water evaporated. The remaining crystals can be compared to known crystals.

**Scaffolding questions**

- How do you find the solubility of a substance?
- Why is “small, white grains” not helpful in identifying this mystery substance?

**Application questions**

- Can two substances have the same saturation point?
- What are other properties that can be used to identify a substance?
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### Questions and What to Listen For

**Step 26:** Have a sense-making discussion

**What to ask**
- What is a simple definition of the biosphere on Earth? *(Analyzing and interpreting data)*
- What is an ecosystem? *(Constructing explanations)*
- What is one way that organisms interact in an ecosystem? *(Constructing explanations; systems and system models)*
- What is the role of producers in an ecosystem? *(Constructing explanations)*
- How might human actions affect the food web in a woodland or a freshwater river? *(Developing and using models; stability and change)*
- How does matter and energy move in the biosphere? *(Developing and using models, Constructing explanations; energy and matter)*

**What to listen for**
- The biosphere is the system of all the interacting living organisms on Earth.
- An ecosystem is part of the biosphere. It is a community of organisms living in the same location that interact with each other and with the nonliving environment.
- Food chains and food webs can describe a feeding relationship.
- Producers make their own food from sunlight, water, and carbon dioxide. They provide the energy and matter (food) for consumers.
- Anything humans do that impacts the survival of one organism in a food web, good or otherwise, impacts all the organisms in that food web.
- The energy comes from the Sun to plants (producers). The matter and energy of the producers moves to the consumers. When the consumers die, their matter and energy move to the decomposers.

**Scaffolding questions**
- Where does energy enter the system?

**Application questions**
- Why is it important for humans to consider their interactions within ecosystems?
### Module: Living Systems

**Investigation 3:** Transport Systems  **Part 2:** Circulatory Systems

**Guiding question:** How do plants and animals get nutrients to all of the cells?

**Focus question:** How do humans transport nutrients to all their cells?

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<td>Organization for matter and energy flow in organisms (LS1.C)</td>
<td><strong>Develop models</strong> to describe phenomena. <strong>Constructing explanations</strong> using evidence.</td>
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#### Questions and What to Listen For

**Step 18:** Have a sense-making discussion

**What to ask**

- *What is the heart and what is its role in the circulatory system?* (Analyzing and interpreting data)
- *What are heart valves and what do they do?* (Analyzing and interpreting data; structure and function)
- *What is the main function of the left side of the human heart? How does our model show that?* (Developing and using models; structure and function)
- *What is the main function of the right side of the human heart? How does our model show that?* (Developing and using models; structure and function)
- *What is the typical path taken by a blood cell as it moves through the human body?* (Constructing explanations; systems and system models)
- *How do the parts function as a system?* (Developing and using models; systems and system models)

**What to listen for**

- The heart is a pump. It pushes blood around in the circulatory system.
- Valves are one-way gates that allow movement of blood in one direction only. Valves keep blood flowing in one direction and prevent it from being pushed in the wrong direction.
- The left ventricle pumps oxygen-rich blood through the arteries in the body. The red blood cells transport oxygen and pick up waste carbon dioxide.
- The right ventricle pumps blood to the lungs. It flows through capillaries to pick up oxygen and release carbon dioxide.
- Blood flows into the right side of the heart from the body. The right ventricle pumps the blood to the lungs. Blood flows from the lungs to the left side of the heart. The left ventricle pumps blood out to all the cells in the body. The blood then returns to the right side of the heart.
- The heart, a muscle with chambers and valves, is connected to the arteries that carry oxygenated blood to the body and the veins that bring waste gas from the body back to the heart and to the lungs. The capillaries form a network between arteries and veins where gas exchange takes place.
- The model does not have four separate chambers like the heart. The model is simpler and does show how blood flows in only one direction. More sophisticated equipment is needed to make a more accurate model.

**Application questions**

- *What are the strengths and limitations of our model?*
- *How could we improve the models we have developed?*
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<td><strong>Constructing explanations</strong> using evidence.</td>
<td>Systems and system models; Patterns</td>
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### Questions and What to Listen For

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

**What to ask**

- **What does the graph tell us about the volume of our lungs?** What evidence do we have? (Analyzing and interpreting data; constructing explanations; patterns)
- **What is the function of the lungs?** (Analyzing and interpreting data; structure and function)
- **What plant structures serve the function of gas exchange?** (Analyzing and interpreting data; structure and function)
- **Why do people breathe?** (Constructing explanations; systems and system models)
- **Why are transport systems important for living organisms?** (Constructing explanations; systems and system models)
- **Think back to Earth’s systems—we are part of the biosphere. How do organisms, like humans, plants, and yeast, interact with the atmosphere?** (Constructing explanations; systems and system models)

**What to listen for**

- Lung volumes vary from person to person but within a range.
- Lungs exchange gases.
- The leaf exchanges gases for the plant. Leaves use carbon dioxide and water to produce sugar and oxygen. Plant cells also use oxygen and produce carbon dioxide.
- Transport systems move resources to cells and waste away from the organisms.

**Scaffolding questions**

- **What do humans get from the atmosphere?**
- **What do humans put back into the atmosphere?**

**Application questions**

- **How do plants and animals get nutrients to their cells?**
### SENSE-MAKING DISCUSSION PLANNING GUIDE

**Module**: Living Systems  
**Investigation 4**: Sensory Systems, Part 1: Stimulus/Response  
**Guiding question**: How do animal sensory systems function in the biosphere?  
**Focus question**: How do humans respond to dangers in the environment?

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<td>Scale, proportion, and quantity; Systems and system models</td>
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### Questions and What to Listen For

**Step 25**: Have a sense-making discussion

**What to ask**
- Describe the system that allows you to move out of the way of a falling object. (Constructing explanations; systems and system models)
- Does it take the same amount of time for hands and feet to respond to a visual stimulus? Why or why not? (Analyzing and interpreting data, constructing explanations; scale, proportion, and quantity)
- What evidence do you have to support that claim? (Constructing explanations; scale, proportion, and quantity)
- How do humans respond to changes in their environments? (Constructing explanations; cause and effect, systems and system models)

**What to listen for**
- A stimulus is received by sensory receptors. The information goes to the brain through a system of sensory neurons in the nervous system. Neurons in the brain make a decision and send a message to our muscles or other systems to take action through motor neurons.
- It takes longer for feet than hands to respond to a visual stimulus because the response message must travel a greater distance.

**Scaffolding questions**
- What happens first when the cup begins to fall? next?

**Application questions**
- What are some examples of stimulus/response with other animals?
- How might a quick response time benefit an organism?
- Can you think of examples of plants responding to a stimulus?