INTRODUCTION—GRADE 6

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.

In Weather and Water Investigation 1, students investigated the properties and particulate nature of air. In the first part of Investigation 2, they assembled pressure indicators to explore the effect of pressure on air. At this point, students have investigated air in closed systems such as syringes to develop an understanding of air pressure. They have interpreted weather maps to determine areas of high and low air pressure, labelling isobars and considering how air might move between such areas. They have drawn arrows on their maps to indicate wind direction and strength. The teacher asks students to bring their notebooks and maps and form a discussion circle, standing shoulder to shoulder next to someone from another group. Partners discuss the question posed on the class notebook, a chart stand placed within the circle. They think about what an air-pressure map reveals about weather while one pair of students places their completed map under the document.
camera to project. They explain the data that their map reveals and share that they think that air moves from high-pressure regions to low-pressure regions. Some students agree and others ask questions. One pair lists the data they need on the chart paper. The teacher listens and asks questions to guide the discussion, encouraging communication between all students, careful to facilitate rather than lead. Students refer to the projected map and others compare their own maps. They review their notebook entries and cite findings from their air pressure experimentation as they develop their explanations. Collaboratively, the class begins to develop a model for wind strength and direction. Considering their ideas, the teacher asks what other factors they think might affect wind strength and direction locally and nationwide. Before returning to their seats and responding to the focus question individually in their notebook, students summarize their models 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 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 or build on their responses to the FOSS focus question.

If your students have had sense-making discussions in their FOSS elementary experience, they will be prepared to jump right in with a little encouragement. They may be able to maintain fruitful discussion for a longer time than their younger counterparts, but may be more distractible. You might find that as you grow comfortable with giving students more ownership of their own learning in this setting, both you and they will want more opportunities than those suggested in the Investigations Guide. Use your intuition. In addition, middle school presents challenges with multiple classes throughout the day. The next section provides suggestions on how to set up class notebooks for each of your classes.

This chapter describes a professional learning process to enhance your abilities to facilitate sense-making discussions of science phenomena with grade 6 students. This chapter will be most useful after you have taught a FOSS course.
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 is one sample of a model sense-making planning guide for each grade 6 course.

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 and Learning about... section. Review the guiding questions for the investigation (on the first page and in the at-a-glance chart), the Scientific and Historical Background, and the Teaching and Learning 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.

2. **Identify when and why to have the discussion**

Plan what to ask and what to listen for.

3. **Plan for adjustments**

6. **Consider language and vocabulary**

5. **Use a class notebook**

**SCIENTIFIC and Historical Background**

In this investigation, students investigate the phenomenon of wind. They explore how air pressure is instrumental in moving air from one area to another. The guiding question for this investigation is what is wind?

Air is mostly a mixture of gas molecules with a sprinkling of atoms and ions. Most of the elementary gases in the air are diatomic, that is, bonded in pairs. For instance, oxygen is virtually never found as a single atom, but is bonded to a second oxygen atom to form an oxygen molecule, O₂. The same is true for nitrogen, the most abundant element in the atmosphere. Other important molecules include water vapor, H₂O, and carbon dioxide, CO₂. Some trace gases exist as solo atoms in the air, but most of the gases are molecules. This is a complex distinction, so with students, we continue to refer to gases as being made of particles.

Gas particles have mass. A mole is the quantity of matter used to compare one material to another. One mole of gas is 6.02 x 10²³ particles of that gas. One mole of oxygen gas at standard temperature (STP) and pressure (1 bar) has a volume of 22.4 L and a mass of 32 g. A typical office wastebasket or a medium-sized trash bag holds about this volume. Individual particles in the atmosphere are free to roam around space as individuals. The Scientific and Historical Background provides information about the content developed during the sense-making discussion.

Students are born into a different environment—an ocean of air. Like the fish in the sea, we are equally unaware of the medium in which we conduct our business. We are programmed to function fully while subjected to the physical presence of a fluid that has mass and viscosity, and that continually exerts pressure on us. Living at the bottom of a sea of air is the default setting for our sensory systems. That's one reason that exploring the pressure dynamics of the atmosphere requires deep thinking and carefully conceived and conducted experiments.

How Does Pressure Affect Air?

Physical properties of air. Air is a mixture of gas molecules with a sprinkling of atoms and ions. Most of the elementary gases in the air are diatomic, that is, bonded in pairs. For instance, oxygen is virtually never found as a single atom, but is bonded to a second oxygen atom to form an oxygen molecule, O₂. The same is true for nitrogen, the most abundant element in the atmosphere. Other important molecules include water vapor, H₂O, and carbon dioxide, CO₂. Some trace gases exist as solo atoms in the air, but most of the gases are molecules. This is a complex distinction, so with students, we continue to refer to gases as being made of particles.

Individual particles in the atmosphere are free to roam around space as individuals.
Sense-Making Discussions for Three-Dimensional Learning

**TEACHING AND LEARNING about Air Pressure**

 Developing Disciplinary Core Ideas (DCI)

“The wind is just something that happens by surprise. You can’t see it, just feel it, and you can’t know if it’s coming.” The wind may seem a mysterious and unpredictable phenomenon to middle school students, and to many adults as well. But we certainly are all familiar with its effects. Hair or dust blowing in your eyes, flags that are grounded, powerful storms that knock down trees or electric lines, delayed sports games, and the traditional summer pastime of kite flying—all of these phenomena depend on changing air pressure. While students can’t see air or wind, in this investigation they will start to learn how to quantify properties of air. How densely are the particles packed in relation to surrounding air? How will the air flow if it is released? How can pressure maps help meteorologists predict wind?

There are many patterns of local winds, and the Coriolis effect will all be explored in the traditional summer pastime of kite flying—all of these phenomena are composed of particles in constant motion with lots of space between them—to explain air pressure in terms of density of particles.

Once the concept of air pressure has been established, students will make connections to real life and consider how air pressure can be measured. The mechanism by which air pressure might change in certain areas, the affect of air pressure in the pressure-indicator jar. Patterns of local winds, and the Coriolis effect will all be explored in the traditional summer pastime of kite flying—all of these phenomena are composed of particles in constant motion with lots of space between them—to explain air pressure in terms of density of particles.

**Exposing Crosscutting Concepts (CC)**

• Patterns: Patterns can be used to identify cause-and-effect relationships. Graphs, charts, and icons can be used to identify patterns in data.

• Cause and effect: Cause-and-effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.

• Scale, proportion, and quantity: Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

**TEACHING AND LEARNING about Air Pressure**

Engaging in Science and Engineering Practices (SEP)

In this investigation, students engage in these practices:

• Asking questions after careful observations of the behavior of the water in the pressure-indicator jar.

• Developing and using models to predict and explain the effects of air pressure on the pressure-indicator jar.

• Conducting investigations and collecting data to explain the effect of air pressure in the pressure-indicator bottle.

• Analyzing and interpreting data presented on an air-pressure map to identify the relationship of pressure and wind direction and relative speed.

• Using mathematics and computational thinking to draw isolars of equal pressure on an air-pressure map.

• Constructing explanations for the behavior of the water in the air-pressure jar, based on qualitative observations and the particulars model for air.

• Obtaining, evaluating, and communicating information by integrating graphical information from text with that in media and visual display to understand principles about air pressure and wind.

The Teaching and Learning about . . . section provides information about the DCIs, SEPs, and CCs emphasized in the investigation.
That means that the other 10% of Earth’s atmosphere is spread over the next 585 km or so. In a practical sense, all the atmosphere that makes a difference to us here on Earth’s surface is smashed close to Earth in a layer no thicker than 10,000 km—the diameter of Earth. If you were to paint a clear lacquer coating on a volleyball, that would represent the troposphere and a bit of the stratosphere, encompassing 90% of Earth’s atmosphere.

Air pressure is affected by other factors as well. When air warms, it expands, becoming less dense. Air that is infused with smaller, lighter particles, such as water vapor, is less dense. Air that is less dense pushes with less pressure. Because the atmosphere is dynamic, masses of air may be warm and moist, creating regions of reduced air pressure. Other areas may cool, creating more dense, high-pressure air masses. When high-pressure air masses interact with low-pressure air masses, interesting weather results.

Air-pressure data are of the greatest importance to meteorologists. Based on the magnitude of pressure differences and the movement of the high-pressure air masses and low-pressure air masses across the land, meteorologists can forecast what the weather has in store for the near future.

Differences in air pressure contribute to wind. Air is everywhere, so the potential for wind is universal. Energy to move air around is in good supply as well. The energy that is responsible for moving air comes from the Sun. The mechanisms by which the Sun heats air will be explored further in later investigations. This investigation focuses solely on what happens when there is different air pressure in different locations.

If there is high pressure in one place and low pressure in another place, air will tend to move from the high-pressure place to the low-pressure place because the air particles are always moving and will equalize pressure, reaching equilibrium, when possible. Movement of air creates wind.

**Isobars** are lines on pressure maps that indicate areas of different air pressure by connecting pressure readings across the area being analyzed. The pattern of isobars indicates areas of high and low air pressure. If the low- and high-pressure areas are far apart or the difference in air pressure is slight, the air pressure gradient (difference between the high and low pressure) will be meager, and the associated wind is only a breeze. If the high- and low-pressure areas are close together and the pressure gradient is great, the associated wind could develop into a gale.

**Conceptual Flow**

The conceptual flow for this investigation begins to unravel the factors that affect weather, starting with the phenomena of air pressure and wind. The guiding question for this investigation is what is wind?

In Part 1, students investigate the phenomenon of air pressure in an air-pressure-jar system. Students observe and explain how air can exert a force. Using the particulate model for air, students explore how density changes when air is compressed or expanded. Air pressure is measured in millibars with a barometer. Air pressure and air density decrease as you rise in the atmosphere.

In Part 2, students construct an air-pressure map by connecting areas of equal pressures. Lines that connect the air-pressure data are called isobars. Areas of high pressure and low pressure can be identified. The phenomenon of wind is created when air masses move from areas of high pressure to areas of low pressure. When isobars are closer together, the change in pressure occurs over a shorter distance and creates stronger winds. Air pressure is not the only factor determining wind direction.
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 construct explanations about a phenomenon. A sense-making discussion should happen after data acquisition to help students organize their thoughts and make evidence-based claims, ultimately preparing them to explain experimental findings, develop a conceptual model, or to answer the focus question. For middle school, plan about 10–15 minutes for the sense-making discussion. This time will vary from day to day and class to class depending on the students’ ability to focus and have fruitful discussion.

To illustrate this process we will use an example from the *Weather and Water Course*, Investigation 2, Air Pressure and Wind. 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 scaffolding questions that will guide students toward the desired understandings (DCIs).

### Notes

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.
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 organ systems in moving oxygen through the body?” or “What causes a canyon to form?” Some of these questions might be found in the Scientific and Historical Background and the Teaching and Learning 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 for the vignette from Weather and Water 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 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.

<table>
<thead>
<tr>
<th>What to ask</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ How does an air-pressure map inform us about weather conditions at different locations?</td>
</tr>
<tr>
<td>➤ When there are areas of high pressure next to areas of low pressure, what weather events happen?</td>
</tr>
<tr>
<td>➤ What data do you need to determine the direction and strength of the wind?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What to listen for</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Air moves from areas of high pressure to areas of low pressure.</td>
</tr>
<tr>
<td>• Areas of equal pressure are represented by isobars.</td>
</tr>
<tr>
<td>• Isobars that are far apart have a gradual change in pressure; isobars that are close together have a rapid change in pressure.</td>
</tr>
<tr>
<td>• Areas where isobars are far apart have gentle winds; areas where isobars are close together have stronger winds.</td>
</tr>
</tbody>
</table>
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 directed 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 humans are most like bread mold because they are both eukaryotes. What other cell structures are unique to eukaryotes?” or “If it takes five times more energy to heat up water than soil 1 degree Celsius, what does that mean when you think of a region that has lakes and forests?” When appropriate, revisit the phenomenon or guiding question 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, a cause-and-effect chart could be made to help students look at specific relationships between variables. Examples of instructional strategies can be found in the Science and Engineering Practices and Crosscutting Concepts and Integration chapters. The next-step strategies found in the Assessment and Science Notebooks in Middle School chapters can also be incorporated into sense-making discussions when appropriate.
## Sense-Making Discussion Planning Guide

### Course
Weather and Water

### Investigation 2: Air Pressure and Wind, Part 2: Pressure Maps

| Guiding question: | What happens when two areas of air have different pressures? |

### 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>Weather and climate (ESS2.D)</td>
<td>Analyzing and interpreting data to provide evidence for phenomena; developing and using models to predict and/or describe phenomena.</td>
<td>Patterns; Cause and Effect</td>
</tr>
</tbody>
</table>

### Questions and What to Listen For

#### Step 11: Have a sense-making discussion

**What to ask**

- How does an air-pressure map inform us about weather conditions at different locations? (Step 11) (Developing and using models; patterns)
- In areas of high pressure next to areas of low pressure, what weather events happen? (Analyzing and interpreting data; cause and effect)
- What data do you need to determine the direction and strength of the wind? (Analyzing and interpreting data; cause and effect)

**What to listen for**

- Air moves from areas of high pressure to areas of low pressure; air movement is wind.
- Areas of equal pressure are represented by isobars.
- Isobars that are far apart have a gradual change in pressure; isobars that are close together have a rapid change in pressure.
- Areas where isobars are far apart have gentle winds; areas where isobars are close together have stronger winds.
- To determine the direction and strength of the wind, you need to be able to read isobars on a weather map and know the air pressure of different adjoining regions.

### Scaffolding questions

- What do isobars represent?
- How can you tell if there will be a gradual or a rapid change in pressure by looking at a weather map?
- What do you think it means when the isobar lines are closer together? (Step 8)
- What do you think it means when the isobar lines are farther apart? (Step 8)
- What could the distance between isobars tell us about how fast the wind is blowing? (Step 8)
- What does the length of the arrow on a wind map indicate?
- When there are regions of low air pressure, in which direction will air move?
- What evidence do you have from the syringe experiment to support the claim that air will flow from areas of high pressure to low pressure?

### Application questions

- What other factors might affect the direction and strength of the wind?
- What causes an area to have high or low pressure? (Step 11)
- What other questions do you have? (Step 11)
Talk moves. Talk moves serve to help all students communicate with each other and advance their models. Several talk moves are possible. 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 in Middle School 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 work to 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.

**REFERENCE**
For more on talk moves, refer to Talk Science Primer, by Sarah Michaels and Cathy O’Connor (Cambridge, MA: TERC, 2012).
Available online at https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf
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. Some teachers use a classroom word wall; others write relevant words on the board or chart paper visible during the discussion. 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. 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. It is helpful to develop a class notebook for use during the discussions. This can be a composition notebook used with a document camera, or chart paper on a stand where everyone can access it. This class notebook serves as a central, visible location for students to share their data and refine their thoughts. You might have one notebook for each class, or you can label each page with the class number for later reference.

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. 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 _____.

NOTE
See the Science Notebooks in Middle School chapter for more information on how students set up and use their notebooks.
CONDUCTING A SENSE-MAKING DISCUSSION

Gathering in a circle is optimal for sense-making discussions. Students should stand shoulder to shoulder so everyone can see each other and the class notebook chart stand or front screen where notebooks are projected. 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 shown here.

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 address challenging content or consider the focus or guiding question with a rich sense-making discussion several times in each course. You will find suggestions in the *Investigations Guides* in the context of the investigation called out by a note in the sidebar. Do not limit yourself to these instances. Rather, take your lead from the students. When they are struggling with a concept, you might find it the perfect opportunity to prepare for a sense-making discussion.
Don’t feel you need to do this as a new FOSS user. Branch out 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 gather 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 a chart, or equipment, bring those as well. If students need to see any projected material, make sure they can see the projection screen.

Begin by reviewing with students the discussion norms. 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 anticipated. 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.
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

<table>
<thead>
<tr>
<th>Course</th>
<th>Weather and Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation 2:</td>
<td>Air Pressure and Wind, Part 2: Pressure Maps</td>
</tr>
<tr>
<td>Guiding question:</td>
<td>What causes wind?</td>
</tr>
<tr>
<td>Focus question:</td>
<td>What happens when two areas of air have different pressures?</td>
</tr>
</tbody>
</table>

#### NEXT GENERATION SCIENCE STANDARDS

<table>
<thead>
<tr>
<th>Focus DC(s)</th>
<th>Focus SEP(s)</th>
<th>Focus CCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather and climate (ESS2.D)</td>
<td>Analyzing and interpreting data to provide evidence for phenomena; developing and using models to predict and/or describe phenomena.</td>
<td>Patterns; Cause and Effect</td>
</tr>
</tbody>
</table>

#### Questions and What to Listen For

**Step 11: Have a sense-making discussion**

**What to ask**
- How does an air-pressure map inform us about weather conditions at different locations? (Step 11) (Developing and using models; patterns)
- When there are areas of high pressure next to areas of low pressure, what weather events happen? (Analyzing and interpreting data; cause and effect)
- What data do you need to determine the direction and strength of the wind? (Analyzing and interpreting data; cause and effect)

**What to listen for**
- Air moves from areas of high pressure to areas of low pressure; air movement is wind.
- Areas of equal pressure are represented by isobars.
- Isobars that are far apart have a gradual change in pressure; isobars that are close together have a rapid change in pressure.
- Areas where isobars are far apart have gentle winds; areas where isobars are close together have stronger winds.
- To determine the direction and strength of the wind, you need to be able to read the isobars on a weather map and know the air pressure of different adjoining regions.

**Scaffolding questions**
- What do isobars represent?
- How can you tell if there will be a gradual or a rapid change in pressure by looking at a weather map?
- What do you think it means when the isobar lines are closer together? (Step 8)
- What do you think it means when the isobar lines are farther apart? (Step 8)
- What could the distance between isobars tell us about how fast the wind is blowing? (Step 8)
- What does the length of the arrows on a weather map indicate?
- When there are regions of low and high pressure next to each other, which direction will wind flow?
- What evidence do you have from the syringe experiment to support the claim that air will flow from areas of high pressure to low pressure?

**Application questions**
- What other factors might affect the direction and strength of the wind?
- What causes an area to have high or low pressure? (Step 11)
- What other questions do you have? (Step 11)
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.

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

**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.
  - Reference data in class notebook.
  - Provide claim-and-evidence frame.

**ADJUST**
- Was all content discussed by all students?
  - No
  - Ask additional question.
  - Ask scaffolding question.
  - Provide sentence frame.
  - End discussion and have students answer focus question individually.
  - Yes
  - End discussion and have students answer focus question individually.

**Scaffolding**
- Provide claim-and-evidence frame.
Before asking the next question on the list, decide what other ideas on the What to Listen For list came forward. If there were none, 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 or revise the focus question in their notebooks, you can review a sample of responses for embedded assessment. See the Assessment chapter for more information on embedded assessment. It’s okay 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 6

On the next 3 pages are examples of sense-making discussion planning guides from the FOSS Next Generation Courses recommended for grade 6—Weather and Water, Diversity of Life, and Human Systems Interactions. 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. The red-text teaching notes are found in the copyright latest FOSS Investigations Guide, which is available to registered users on FOSSweb.

The three samples in this chapter are offered as examples, and should be customized to meet the needs of your students. There is one sample per course. 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.

### Grade 6 Sense-Making Discussion Opportunities

<table>
<thead>
<tr>
<th>Instructional opportunity</th>
<th>Disciplinary Core Idea</th>
<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weather and Water</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inv. 2, Part 2, Step 11</td>
<td>ESS2.D: Weather and climate</td>
<td>Developing and using models; analyzing and interpreting data</td>
<td>Patterns; cause and effect</td>
</tr>
<tr>
<td>Inv. 3, Part 3, Step 8</td>
<td>PS3.B: Conservation of energy and energy transfer; ESS2.D: Weather and climate</td>
<td>Analyzing and interpreting data</td>
<td>Cause and effect; systems, and system models; scale, proportion, and quantity</td>
</tr>
<tr>
<td>Inv. 4, Part 3, Step 14</td>
<td>PS3.B: Conservation of energy and energy transfer</td>
<td>Developing and using models; constructing explanations</td>
<td>Systems and system models; stability and change; energy and matter</td>
</tr>
<tr>
<td>Inv. 5, Part 3, Step 10</td>
<td>ETS1.B: Developing possible solutions; ETS1.C: Optimizing the design solution</td>
<td>Asking questions and defining problems; analyzing and interpreting data</td>
<td>Cause and effect; energy and matter</td>
</tr>
<tr>
<td>Inv. 6, Part 3, Step 16</td>
<td>ESS2.D: Weather and climate; PS3.B: Conservation of energy and energy transfer</td>
<td>Developing and using models; analyzing and interpreting data; constructing explanations</td>
<td>Cause and effect; systems, and system models; energy and matter</td>
</tr>
<tr>
<td>Inv. 7, Part 3, Step 24</td>
<td>PS3.A: Definitions of energy; ESS2.C: The roles of water in Earth's surface processes</td>
<td>Constructing explanations</td>
<td>Cause and effect; energy and matter</td>
</tr>
<tr>
<td>Inv. 8, Part 1, Step 21</td>
<td>ESS2.C: The roles of water in Earth's surface processes; ESS2.D: Weather and climate</td>
<td>Developing and using models; constructing explanations</td>
<td>Systems and system models; stability and change</td>
</tr>
<tr>
<td>Inv. 9, Part 2, Step 17</td>
<td>ESS2.D: Weather and climate; ESS3.D: Global climate change</td>
<td>Analyzing and interpreting data; Constructing explanations</td>
<td>Patterns; systems and system models; energy and matter</td>
</tr>
<tr>
<td>Instructional opportunity</td>
<td>Disciplinary Core Idea</td>
<td>Science and Engineering Practices</td>
<td>Crosscutting Concepts</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------</td>
<td>-----------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Diversity of Life</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inv. 1, Part 2, Step 35</td>
<td>LS1.A: Structure and function</td>
<td>Engaging in argument from evidence</td>
<td>Patterns</td>
</tr>
<tr>
<td>Inv. 4, Part 4, Step 11</td>
<td>LS1.A: Structure and function</td>
<td>Developing and using models; analyzing and interpreting data; engaging in argument from evidence</td>
<td>Patterns; systems and system models; structure and function</td>
</tr>
<tr>
<td>Inv. 6, Part 3, Step 17</td>
<td>LS1.B: Growth and development of organisms</td>
<td>Constructing explanations; obtaining, evaluating, and communicating information</td>
<td>Cause and effect</td>
</tr>
<tr>
<td>Inv. 7, Part 2, Step 15</td>
<td>LS3.B: Variation of traits</td>
<td>Constructing explanations</td>
<td>Patterns, cause and effect</td>
</tr>
<tr>
<td>Inv. 9, Part 2, Step 14</td>
<td>LS1.A: Structure and function</td>
<td>Constructing explanations; engaging in argument from evidence</td>
<td>Patterns; systems and system models; structure and function</td>
</tr>
<tr>
<td>Human Systems Interactions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inv. 2, Part 2, Step 14</td>
<td>LS1.A: Structure and function; LS1.C: Organization for matter and energy flow in organisms</td>
<td>Developing and using models; constructing explanations</td>
<td>Systems and system models; energy and matter</td>
</tr>
<tr>
<td>Inv. 3, Part 1, Step 15</td>
<td>LS1.A: Structure and function; LS1.D: Information processing</td>
<td>Developing and using models; planning and carrying out investigations; engaging in argument from evidence</td>
<td>Systems and system models; structure and function</td>
</tr>
</tbody>
</table>
### SENSE-MAKING DISCUSSION PLANNING GUIDE

<table>
<thead>
<tr>
<th>Course</th>
<th>Weather and Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investigation 2:</strong></td>
<td>Air Pressure and Wind, <strong>Part 2:</strong> Pressure Maps</td>
</tr>
<tr>
<td><strong>Guiding question:</strong></td>
<td>What causes wind?</td>
</tr>
<tr>
<td><strong>Focus question:</strong></td>
<td>What happens when two areas of air have different pressures?</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>Weather and climate (ESS2.D)</td>
<td>Analyzing and interpreting data to provide evidence for phenomena; developing and using models to predict and/or describe phenomena.</td>
<td>Patterns; Cause and Effect</td>
</tr>
</tbody>
</table>

### Questions and What to Listen For

**Step 11: Have a sense-making discussion**

**What to ask**
- How does an air-pressure map inform us about weather conditions at different locations? *(Step 11)* (Developing and using models; patterns)
- When there are areas of high pressure next to areas of low pressure, what weather events happen? *(Analyzing and interpreting data; cause and effect)*
- What data do you need to determine the direction and strength of the wind? *(Analyzing and interpreting data; cause and effect)*

**What to listen for**
- Air moves from areas of high pressure to areas of low pressure; air movement is wind.
- Areas of equal pressure are represented by isobars.
- Isobars that are far apart have a gradual change in pressure; isobars that are close together have a rapid change in pressure.
- Areas where isobars are far apart have gentle winds; areas where isobars are close together have stronger winds.
- To determine the direction and strength of the wind, you need to be able to read the isobars on a weather map and know the air pressure of different adjoining regions.

**Scaffolding questions**
- What do isobars represent?
- How can you tell if there will be a gradual or a rapid change in pressure by looking at a weather map?
- What do you think it means when the isobar lines are closer together? *(Step 8)*
- What do you think it means when the isobar lines are farther apart? *(Step 8)*
- What could the distance between isobars tell us about how fast the wind is blowing? *(Step 8)*
- What does the length of the arrows on a weather map indicate?
- When there are regions of low and high pressure next to each other, which direction will wind flow?
- What evidence do you have from the syringe experiment to support the claim that air will flow from areas of high pressure to low pressure?

**Application questions**
- What other factors might affect the direction and strength of the wind?
- What causes an area to have high or low pressure? *(Step 11)*
- What other questions do you have? *(Step 11)*
SENSE-MAKING DISCUSSION PLANNING GUIDE

<table>
<thead>
<tr>
<th>Course</th>
<th>Diversity of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investigation 4:</strong> Domains, <strong>Part 4:</strong> Archaea: The Three Domains</td>
<td></td>
</tr>
<tr>
<td><strong>Guiding question:</strong> Which of these am I most like: bacteria, bread mold, or archaea?</td>
<td></td>
</tr>
<tr>
<td><strong>Focus question:</strong> What are the characteristics of archaea?</td>
<td></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>Structure and function (LS1.A)</td>
<td>Developing and using models to describe phenomena; analyzing and interpreting data to provide evidence for phenomena; engaging in argument from evidence to support or refute an argument.</td>
<td>Patterns; systems and system models; structure and function</td>
</tr>
</tbody>
</table>

**Questions and What to Listen For**

**Steps 6, 10, and 11:** Have a sense-making discussion

**What to ask**

- **What is your evidence for humans being most like archaea/bread mold/E.coli bacteria? (Steps 6,10)** (Engaging in argument from evidence; developing and using models; analyzing and interpreting data; patterns, systems and system models, structure and function)
- **What is your evidence against humans being most like archaea/bread mold/E.coli bacteria? (Steps 6,10)** (Engaging in argument from evidence; developing and using models; analyzing and interpreting data; patterns, systems and system models, structure and function)

**What to listen for**

- Humans and bread mold are both eukaryotes; they have nuclei in their cells. Bacteria and archaea are prokaryotes; they do not have nuclei in their cells.
- Humans and bread mold are in the same domain.
- Even though archaea have ribosomes that are more like human ribosomes than bacterial ribosomes, they don’t have nuclei.
- Archaean cells have unique modifications of the cell membrane and cell wall.

**Scaffolding questions**

- What are the structures in each organism’s cells?
- What are the most important structures to consider when thinking about how organisms are classified?
- **Which of the three organisms has a nucleus in its cells? (Step 11)**
- **Do humans have nuclei in our cells? (Step 11)**
- **What does that imply? (Step 11)**

**Application questions**

- What other cell structures are unique to eukaryotes? [Mitochondria and chloroplasts.]
- What cell structures are unique to prokaryotes? [Plasmids.]
- If all life shares common characteristics of life and functions, how can we explain why organisms have such different structures?
## SENSE-MAKING DISCUSSION PLANNING GUIDE

<table>
<thead>
<tr>
<th>Course</th>
<th>Human Systems Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investigation 2:</strong> Supporting Cells, <strong>Part 2:</strong> Aerobic Cellular Respiration</td>
<td></td>
</tr>
<tr>
<td><strong>Guiding question:</strong> How does the human body obtain energy and use it to live?</td>
<td></td>
</tr>
<tr>
<td><strong>Focus question:</strong> How does the energy in food become energy that cells can use?</td>
<td></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>Structure and function (LS1.A); Organization for matter and energy flow in organisms (LS1.C)</td>
<td>Developing and using models to describe phenomena; construct, revise, and use explanations for real-world phenomena.</td>
<td>Systems and system models; energy and matter</td>
</tr>
</tbody>
</table>

### Questions and What to Listen For

**Steps 12–14:** Have a sense-making discussion

**What to ask**

- **How does your model illustrate how the energy in food becomes energy that cells can use?** (Step 14) (Developing and using models; energy and matter)
- **How is the movement of oxygen and food described in your model?** (Developing and using models; energy and matter)
- **What is the function of the different organ systems in moving food and oxygen?** (Constructing explanations; systems and system models)
- **What happens to food and oxygen in the cells?** (Constructing explanations; energy and matter)
- **What happens to the products of aerobic cellular respiration?** (Constructing explanations; energy and matter)
- **What is the function of the different organ systems in removing carbon dioxide and water?** (Constructing explanations; systems and system models)

**What to listen for**

- Oxygen is brought into the body by the respiratory system and food is brought in by the digestive system.
- The circulatory system collects the oxygen and food (glucose) and delivers them to the cells.
- Aerobic cellular respiration is the process that uses oxygen and glucose to make energy available to cells.
- The circulatory system collects the waste products, carbon dioxide and water, and delivers them to the respiratory system and excretory system to be removed from the body.

**Scaffolding questions**

- **Where in your model is energy released?** (Step 12)
- **What substances are necessary for aerobic cellular respiration?** (Step 12)
- **How does your model show where the substances come from?** (Step 12)
- **How does your model show how these substances get to cells?** (Step 12)
- **Where does aerobic cellular respiration occur?**
- **What happens to the energy produced?**
- **What happens to the waste products produced?**

**Application questions**

- **What might happen if any part of the cell-support system stops functioning?**
- **Which organ (heart, lungs, blood, etc.) would you consider the most important in the human body?** What is your evidence for your claim?
- **What is the energy that is produced by the cells (from the energy in food) used for?**