INTRODUCTION—GRADE 7

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.

Throughout the Populations and Ecosystems course, students monitor a milkweed bug population and document its changes. By Investigation 7, they have several months of population data. In the first part of Investigation 7, students considered patterns in the data and thought about how big the population could be in a month or year. They learned about reproductive potential and were presented with information and scaffolds to help them calculate the potential population size, then identified limiting factors that could prevent a population from reaching its potential. At this point in the investigation, students use an online simulation to manipulate variables in a milkweed bug habitat and determine effects on population size. They have gathered data from the simulation results and analyzed the data in their groups. The teacher asks students to bring their notebooks 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 which of the five variables has the largest effect on population size, and they use evidence to support their claims. One student shares their group’s data under the document camera as their partner describes how the data supports their claim. Some students agree and others ask questions. One pair records supporting evidence 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 data and others compare their own data. They review their notebook entries and cite findings the simulation as they develop their explanations. Collaboratively, the class begins to make sense of the simulation data to draw conclusions about limiting factors. 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 7 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 7 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.
Sense-Making Discussions for Three-Dimensional Learning

The Teaching and Learning about ... section provides information about the DCIs, SEPs, and CCs emphasized in the investigation.

### Exposing Crosscutting Concepts (CC)

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

- **Patterns**: Patterns in rates of change and other numerical relationships can provide information about natural and human-designed systems. Patterns can be used to predict phenomena in natural or designed systems. Patterns may have more than one cause, and some causes and effect relationships in systems can only be described using probability.

- **Scale, proportion, and quantity**: The scale size within an ecosystem is interrelated with other organisms and depend on limiting factors.

- **Systems and system models**: System models predict population sizes when all variables but one are controlled. These models are limited because in the natural ecosystem, variables cannot be controlled.

### Connections to the Nature of Science

- **Scientific knowledge assumes an order and consistency in natural systems**: Science assumes that order and patterns in nature are consistent patterns that are understandable through measurement and observation. Science carefully considers and evaluates outcomes in data and evidence.

- **Connections to Engineering, Technology, and Applications of Science**: Influence of engineering, technology, and science on society and the natural world. The use of technologies are driven by people's needs, desires, and values by the findings of scientific research, and by differences in such factors as climate, natural resources, and economic conditions.
Planning and Preparing for Sense-Making Discussions

Scientific and Historical Background

Key information in ecology is identifying which organisms participate in the web, and the connections among those players. The more connections within the web, the greater the flexibility of the system. A well-developed web helps us understand how each population limits other populations with which it interacts.

What Factors Affect How Many Milkweed Bugs Could Be in Your Habitat at the End of a Year?

An interesting exercise in population studies is to calculate the reproductive potential of an organism, assuming all limiting factors were removed. How large would the population be after a day, a week, a year, 100 years, and so on? In order to tackle this math problem, you have to know quite a bit about the organism’s reproductive biology.

- How long does it take to reach reproductive maturity?
- How often does it reproduce?
- How many times does it reproduce?
- How many offspring does it produce?
- How long does it live after reproducing?

Notice there are no questions about access to resources or the presence of predators or competitors. We are thinking about a theoretical environment where no pressures from above or below limit population growth.

As an example, the female African elephant reaches reproductive maturity at 10 years, produces a calf every 4 years, and may remain reproductively active until age 85. Elephants can live 60 years. These stats suggest that every female will produce ten offspring over a 40-year reproductive life, and the 10 years after that. Half of her offspring are female, each of whom will produce ten grandchildren. Altogether, the single female will have produced 10 children and 90 grandchildren with the potential for a total of 250 great-grandchildren. Contrast this modest population growth to the reproductive potential of the Atlantic cod. Costmass reaches 2 years, and a five-spawn might produce 250,000 eggs. A female cod might live 20 years under ideal circumstances, spawning more than once a year. A 20-year-old female might produce 12 million eggs in one spawn! If we pick an arbitrary average female cod that will produce 6 million eggs, she will produce 3 million male cod and 3 million female cod. Each of those 3 million average females will spawn 6 million offspring, for a total of 18 billion.

Notice there are no questions about access to resources or the presence of predators or competitors. We are thinking about a theoretical environment where no pressures from above or below limit population growth.

In Part 1, students explore the phenomenon of milkweed-bug population growth. They calculate the reproductive potential of the milkweed bugs in the classroom habitat. Students learn that the predicted number does not match data from classroom habitat observations, so they investigate the biotic and abiotic factors that limit the population in online simulations.

In Part 2, students explore the phenomenon of population growth in controlled environments. They analyze data from laboratory experiments of brine shrimp and algae from Mono Lake. Abiotic factors, light and temperature, limit the brine shrimp and algae populations throughout the year.

In Part 3, students analyze data from interdependent Mono Lake populations of algae, brine shrimp, brine flies, and migratory birds throughout the year. Students analyze the ecosystem interactions that result in limiting factors on populations through the year.

Teaching and Learning about Population Size

Conceptual Flow

The conceptual flow of this investigation follows the phenomenon that population size does not increase forever. The guiding question is how do limiting factors help support a sustainable ecosystem?

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Knowing where concepts are addressed and how they are related helps determine what ideas to pursue during the discussion and which ones can be addressed during the next part.

Sense-Making Discussions for Three-Dimensional Learning—Grade 7
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 Populations and Ecosystems Course, Investigation 7, Reproductive Potential. 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).

**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.
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, “How does the model illustrate what happened when the chocolate melted?” 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 Populations and Ecosystems 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.

Give students a few minutes to summarize their ideas about how biotic and abiotic factors limit the population.

30. Assess progress: notebook entry

Students used controlled variables in an online model and evaluated results from an investigation to determine what factors might affect milkweed-bug population growth in their classroom. Collect the notebooks opened to the page with their responses to the focus question, and use a sample to consider students’ thinking about limiting factors.

What to Look For

- Simulation results provide evidence that volume of space has the greatest affect on limiting a milkweed-bug population.
- Simulation results provide evidence that temperature is a limiting factor for milkweed-bug hatching, while humidity and light are not.
- Temperature may limit locations where milkweed bugs can live.

Plan to spend 15 minutes reviewing the selected student responses. Using Embedded Assessment Notes as a tool, review the responses, record any alternative concepts that are evident, and decide if any next-step strategies are required before moving forward.

After your review, return the sheets to students to be taped or glued into their science notebooks.

What to listen for

- Volume of space has the largest effect on population growth.
- The other factors only influence the population growth over the first few months and then the population stabilizes.
- The number of females, clutch frequency, number of eggs per clutch, and survival rate are biotic factors.
- Volume of space is an abiotic factor.
- All of the biotic factors only limit the length of time for the population to stabilize. Volume of space limits the number that can live in the available space.

What to ask

> Which factors affected population growth in the first few months?
> Which factors affected population growth throughout the entire 14-month cycle?
> What does the word biotic mean?
> What does the word abiotic mean?
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, “How is running a computer simulation different than real-world ecosystem interactions? How can simulations help us predict real-world ecosystem interactions?” or “If we find fossils of organisms and we don’t know their age can we use them as index fossils?”

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

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<tr>
<th><strong>Course</strong></th>
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#### NEXT GENERATION SCIENCE STANDARDS

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#### Questions and What to Listen For

**Steps 21–22:** Have a sense-making discussion (using notebook sheet 36)

**What to ask**

- **Which of the five variables has the largest effect on population size?** *(Notebook sheet 36)* (Developing and using models; cause and effect)
- **Is your evidence?** *(Notebook sheet 36)* (Analyzing and interpreting data; cause and effect)
- **Which of the variables are biotic factors?** *(Notebook sheet 36)* (Developing and using models; systems and system models)
- **Which of the variables are abiotic factors?** *(Notebook sheet 36)* (Developing and using models; systems and system models)
- **How does each variable act as a population limiting factor?** *(Notebook sheet 36)* (Developing and using models; stability and change)

**What to listen for**

- Volume of space has the largest effect on population growth.
- The other factors only influence the population growth over the first few months and then the population stabilizes.
- The number of females, clutch frequency, number of eggs per clutch, and survival rate are biotic factors.
- Volume of space is an abiotic factor.
- The biotic factors only limit the length of time for the population to stabilize.
- Volume of space limits the number that can live in the available space.

**Scaffolding questions**

- Which factors affected population growth in the first two months?
- Which factors affected population growth throughout the entire 14-month cycle?
- What does the word **biotic** mean?
- What does the word **abiotic** mean?

**Application questions**

- How is running a computer simulation different than real-world ecosystem interactions? How can simulations help us predict real-world ecosystem interactions?
- How might computer modeling be used by scientists to investigate climate change? What would be the strengths and potential weaknesses?
- The only abiotic factor that we considered was volume of space available, and it had the largest effect on population size. Does this imply that abiotic factors always have the largest effect? Why or why not? What other abiotic factors might have an effect?
- What other real-life factors might influence population growth?
- What other questions would you explore?

*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.*
**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**

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.
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.
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.

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### Questions and What to Listen For

**Steps 21–22:** Have a sense-making discussion (using notebook sheet 36)

**What to ask**
- Which of the five variables has the largest effect on population size? (Notebook sheet 36) (Developing and using models; cause and effect)
- What is your evidence? (Notebook sheet 36) (Analyzing and interpreting data; cause and effect)
- Which of the variables are biotic factors? (Notebook sheet 36) (Developing and using models; systems and system models)
- Which of the variables are abiotic factors? (Notebook sheet 36) (Developing and using models; systems and system models)
- How does each variable act as a population limiting factor? (Notebook sheet 36) (Developing and using models; stability and change)

**What to listen for**
- Volume of space has the largest effect on population growth.
- The other factors only influence the population growth over the first few months and then the population stabilizes.
- The number of females, clutch frequency, number of eggs per clutch, and survival rate are biotic factors.
- Volume of space is an abiotic factor.
- All of the biotic factors only limit the length of time for the population to stabilize.
- Volume of space limits the number that can live in the available space.

**Ask content question.**

**Ask scaffolding question.**

**Ask additional question.**
**Conducting a Sense-Making Discussion**

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

**Sense-Making Discussions for Three-Dimensional Learning—Grade 7**
Before asking the next question on the list, decide what other ideas on the What to Listen For list came forward. Otherwise, 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 them 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 7

On the next 3 pages are examples of sense-making discussion planning guides from the FOSS Next Generation Courses recommended for grade 7—Chemical Interactions, Earth History, and Populations and Ecosystems. 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 7 Sense-Making Discussion Opportunities

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SENSE-MAKING DISCUSSION PLANNING GUIDE

Course: Chemical Interactions

Investigation 7: Solutions, Part 1: Dissolve and Melt

Guiding question: How do substances dissolve?

Focus question: What is the difference between dissolving and melting?

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Questions and What to Listen For

Steps 11–13: Have a sense-making discussion

What to ask

➤ How does the model illustrate what happened when the candy coating dissolved? (Developing and using models; cause and effect)

➤ What happened to the candy coating at the particle level when it dissolved? (Step 12) (Developing and using models; cause and effect)

➤ What was between the particles of candy coating after it dissolved? (Step 12) (Constructing explanations; systems and system models)

➤ How does the model illustrate what happened when the chocolate melted? (Developing and using models; cause and effect)

➤ What happened to the chocolate at the particle level when it melted? (Step 12) (Developing and using models; cause and effect)

➤ What was between the particles of chocolate after it melted? (Step 12) (Constructing explanations; systems and system models)

What to listen for

• The candy coating dissolved in the water. It did not dissolve in hot or cold air.
• The candy coating dissolved in both warm and cold water, but dissolved more quickly in warm water.
• Particles of water collided with the candy coating, breaking off particles of coating, which moved into the water.
• Particles of water were between the particles of candy coating.
• The chocolate melted in hot air and in hot water.
• The chocolate melted as a result of energy transfer. The chocolate particles moved more quickly and started moving around and past each other.
• Only other particles of chocolate were between the particles of chocolate.

Scaffolding questions

➤ What conditions were necessary for the candy coating to dissolve? What is your evidence?

➤ What evidence do you have that the candy coating went into the water?

➤ What conditions were necessary for the chocolate to melt? What is your evidence?

➤ What evidence is there that energy transferred to the chocolate?

Application questions

➤ If you wanted to dissolve drink powder in water quickly, what could you do?

➤ If you decrease the kinetic energy of the particles of a liquid by cooling it, how might that affect substances dissolving in the liquid?

➤ Water is called the universal solvent. Why do you think that might be so? Why might this characteristic of water be important for life?
SENSE-MAKING DISCUSSION PLANNING GUIDE

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<td>Guiding question:</td>
<td>What can fossils tell us about Earth’s past?</td>
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<td>Focus question:</td>
<td>When did the Grand Canyon rocks form?</td>
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Questions and What to Listen For

**Step 15: Have a sense-making discussion**

**What to ask**

- What role do index fossils have in helping identify the age of rock layers? (Constructing explanations; patterns)
- How do index fossils help us figure out how the sedimentary rocks on the left are related to the sedimentary rocks on the right? (Step 15) (Constructing explanations; patterns)

**What to listen for**

- Index fossils give us information to correlate the rock layers they are found in.
- If we know the age of the organisms that became fossils, we can identify the age of the rock in which they are found.
- Good index fossils represent species that lived for a relatively short period of time and lived in many places.
- In the top diagram, the rocks sticking up must have weathered and eroded away.
- The pattern of fossils found in the layers on the left match the pattern of fossils found in the layers on the right, so we can infer the layers may have been connected at some point. (May need more evidence from the rocks.)

**Scaffolding questions**

- What characteristics make a fossil a good index fossil?
- What do fossils tell us about the age of the rock layers in which they are found?
- What happened to the rocks sticking up, represented with the dotted lines? (Step 15)
- How do we know that the sedimentary rocks were folded into a curved shape after they formed? (Step 15)

**Application questions**

- Why might it be helpful to be able to infer the rock layers under a particular spot? (Step 15)
- If we find fossils of organisms and we don’t know their age can we use them as index fossils?
- What other techniques could we use to determine the age of a rock layer? (This question leads into the discussion of radioactive dating; students may not have heard of this type of rock dating.)
### NEXT GENERATION SCIENCE STANDARDS

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### Questions and What to Listen For

**Steps 21–22: Have a sense-making discussion (using notebook sheet 36)**

**What to ask**

- Which of the five variables has the largest effect on population size? (Notebook sheet 36) (Developing and using models; cause and effect)
- What is your evidence? (Notebook sheet 36) (Analyzing and interpreting data; cause and effect)
- Which of the variables are biotic factors? (Notebook sheet 36) (Developing and using models; systems and system models)
- Which of the variables are abiotic factors? (Notebook sheet 36) (Developing and using models; systems and system models)
- How does each variable act as a population limiting factor? (Notebook sheet 36) (Developing and using models; stability and change)

**What to listen for**

- Volume of space has the largest effect on population growth.
- The other factors only influence the population growth over the first few months and then the population stabilizes.
- The number of females, clutch frequency, number of eggs per clutch, and survival rate are biotic factors.
- Volume of space is an abiotic factor.
- All of the biotic factors only limit the length of time for the population to stabilize. Volume of space limits the number that can live in the available space.

**Scaffolding questions**

- Which factors affected population growth in the first few months?
- Which factors affected population growth throughout the entire 14-month cycle?
- What does the word biotic mean?
- What does the word abiotic mean?

**Application questions**

- How is running a computer simulation different than real-world ecosystem interactions? How can simulations help us predict real-world ecosystem interactions?
- How might computer modeling be used by scientists to investigate climate change? What would be the strengths and potential weaknesses?
- The only abiotic factor that we considered was volume of space available, and it had the largest effect on population size. Does this imply that abiotic factors always have the largest effect? Why or why not? What other abiotic factors might have an effect?
- What other real-life factors might influence milkweed-bug population growth?
- What other questions would you explore?