INTRODUCTION

In this chapter, we explore the intersection of science and language and the implications for effective science teaching and language development. We identify best practices in language arts instruction that support science learning and examine how student engagement in the science and engineering practices (SEPs) supports literacy. The active investigations, science notebooks, FOSS Science Resources readings, and formative assessment activities in FOSS provide rich contexts in which students develop and exercise thinking processes and communication skills. Together, these elements comprise effective instruction in both science and language arts—students experience the natural world around them in real and authentic ways and use language to inquire, process information, and communicate their thinking about scientific phenomena. We refer to the development of language within the context of science as science-centered language development.

Teams of science inquirers talk about and write about their questions, their tentative explanations, their relationships between evidence and explanations, and their reasons and judgments about public presentations and scientific arguments in behalf of their work. It is in the context of this kind of scientific activity that students’ literacy of the spoken and written word develops along with the literacy of the phenomenon.

Hubert M. Dyasi, “Visions of Inquiry: Science”
Language plays two crucial roles in science learning: (1) it facilitates the communication of conceptual and procedural knowledge, questions, and propositions (external, public), and (2) it mediates thinking, a process necessary for understanding (internal, private). These are also the ways scientists use language: to communicate with one another about their inquiries, procedures, and understandings; to transform their observations into ideas; and to create meaning and new ideas from their work and the work of others. For students, language development is intimately involved in their learning about the natural world. Science provides a real and engaging context for developing literacy; language arts skills and strategies support conceptual development and engagement in the SEPs. For example, the skills and strategies used for reading comprehension, writing expository text, and oral discourse are applied when students are recording their observations, making sense of phenomena, and communicating their ideas. Students’ use of language improves when they discuss, write, and read about the concepts explored in each investigation.

We begin our exploration of science and language by focusing on language functions and how specific language functions are used in science to facilitate information acquisition and processing (thinking). Then we describe ways to integrate English Language Arts (ELA) approaches and English Language Development (ELD) strategies purposefully into the FOSS investigations to both enhance students’ learning in science and develop proficiency in the ELA strands of speaking and listening, writing, and reading.

Each section addresses

- how knowledge and skills in that strand are developed and exercised in FOSS investigations;
- literacy strategies that are integrated purposefully into the FOSS investigations;
- suggestions for additional literacy strategies that both enhance student learning in science and develop or exercise academic language skills critical for all content areas.

Following the discussions of the three ELA strands is a section specifically devoted to science-vocabulary development, with scaffolding strategies for supporting all learners. The last section covers language-development strategies for English learners and for students who need additional literacy support. The focus of this section is ensuring access to the learning experience as well as developing academic English and the language structures specific to the discipline of science and engineering.
THE ROLE OF LANGUAGE IN SCIENCE AND ENGINEERING PRACTICES

Language functions are the purpose for which speech or writing is used and involve both vocabulary and grammatical structure. Understanding and using language functions appropriately is important in effective communication. Students use numerous language functions in all disciplines to mediate communication and facilitate thinking (e.g., they plan, compare, discuss, apply, design, draw, and provide evidence).

In science, language functions facilitate engagement in the science and engineering practices. For example, when students are collecting data, they are using language functions to identify, label, enumerate, compare, estimate, and measure. When students are constructing explanations, they are using language functions to analyze, communicate, discuss, evaluate, and justify.

The Framework for Science Education (National Research Council, 2010) affirms that “students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing the practices for themselves.” Each of these practices requires the use of multiple language functions. Often, these language functions are part of an internal dialogue weighing the merits of various explanations—what we call thinking. The more language functions with which we are facile, the more effective and creative our thinking can be. Though students in K–2 are just beginning their formal explorations into science and engineering, they come to school full of curiosity and enthusiasm, ready to engage in the science and engineering practices at their level of development.

The science and engineering practices are summarized below, along with a sample of the language functions that are exercised when students are effectively engaged in that practice. (Practices are bold; language functions are italic.)

### 1. Asking questions and defining problems

- Ask questions based on observations about objects, organisms, phenomena, and events in the natural and human-made world.
- Identify questions that can be answered by investigations.
- Define a simple problem that can be solved.

### 2. Developing and using models

- Develop and use models to represent amounts, relationships, relative scales, and patterns.
- Develop models based on evidence to represent an object or tool.
- Distinguish between models and actual phenomena.
- Compare models to identify common features and differences.
3. Planning and carrying out investigations

- With guidance, plan and conduct investigations with peers (K).
- Plan and conduct investigations collaboratively to produce data as evidence to answer a question.
- Evaluate different ways of observing and measuring a phenomenon to determine how to answer a question.
- Observe, measure, and collect data to make comparisons and to determine if a proposed object, tool, or solution solves a problem or meets a goal.
- Predict outcomes based on prior experience.

4. Analyzing and interpreting data

- Record observations, thoughts, and ideas.
- Share observations using drawings and writing.
- Describe patterns and relationships based on observations to answer questions or solve problems.
- Compare predictions to what occurred.
- Analyze data from tests of an object or tool to determine if it works as intended.

5. Using mathematics and computational thinking

- Determine whether to use qualitative or quantitative data.
- Use counting and numbers to identify and describe patterns.
- Describe, measure, and compare quantitative attributes of different objects and display the data using simple graphs.
- Compare two alternative solutions using quantitative data.

6. Constructing explanations and designing solutions

- Use observations to construct an evidence-based account of phenomena.
- Design and build a device that solves a problem.
- Generate and compare multiple solutions to a problem.

7. Engaging in argument from evidence

- Distinguish between explanations that account for all gathered evidence and those that do not.
- Analyze why some evidence is relevant and some is not.
The Role of Language

- Distinguish between opinions and evidence in one’s own explanation.
- Listen actively to arguments. Agree and disagree based on evidence; retell the main points of an argument.
- Construct and support an argument with evidence to support a claim.
- Make a claim about the effectiveness of an object, tool, or solution based on evidence.

8. Obtaining, evaluating, and communicating information

- Read to obtain scientific and technical information to determine patterns or evidence.
- Describe how specific images support a scientific or engineering task.
- Obtain information using various texts, text features, and other media to answer questions and support claims.
- Communicate information or design ideas/solutions orally and in writing, using models, drawings, or numbers to provide details.

Research supports the claim that when students are intentionally using language functions in thinking about and communicating in science, they improve not only science content knowledge, but also language-arts and mathematics skills (Ostlund, 1998; Lieberman and Hoody, 1998). Language functions play a central role in science as a key cognitive tool for developing higher-order thinking and problem-solving abilities that, in turn, support academic literacy in all subject areas.

Here is an example of how an experienced teacher can provide an opportunity for students to exercise language functions in FOSS. In the Materials and Motion Module (Kindergarten), this is one piece of content we expect students to have acquired by the end of the module.

- When objects touch or collide, they push on one another, which can change motion.

The science and engineering practices the teacher wants the class to focus on are designing solutions and analyzing and interpreting data.

The language functions students will exercise while engaging in these practices are designing, analyzing, comparing, and explaining. The teacher understands that these language functions are appropriate to the purpose of the science investigation and support the Common Core Standards for writing (students will use a combination of drawing,
dictating, and writing to compose explanatory texts in which they name what they are writing about and supply some information about the topic.)

Students will compare observational data (from a ball and ramp design challenge) to explain how they were able to change the direction of a ball moving down a ramp.

The teacher can support the use of language functions by providing structures such as sentence frames.

- *When I _____, then _____.*

  *When I put a block in the path of the ball, it went toward the pond.*
The FOSS investigations are designed to engage students in productive oral discourse. Talking requires students to process and organize what they are learning. Listening to and evaluating peers’ ideas calls on students to apply their knowledge and to sharpen their reasoning skills. Guiding students in small-group and whole-class discussions is critical to the development of conceptual understanding of the science content and the ability to think and reason scientifically. It also addresses a key Common Core Speaking and Listening standard that students “participate in collaborative discussions with diverse partners on topics and texts with peers and adults” CCSS.ELA SL1. Students’ ability to engage in higher level academic discourse in science progresses as they move from kindergarten to second grade. Kindergartners begin by learning the norms for discussions and gradually become proficient at continuing a conversation through multiple exchanges. By second grade, students are effectively building on each others’ ideas and asking for clarification and explanations.

FOSS investigations start with a discussion—either a review to activate prior knowledge, the presentation of a focus question, or a challenge to motivate and engage active thinking about a phenomenon. During the active investigation, students talk with one another in small groups, share their observations and discoveries, point out connections, ask questions, and start to build explanations. The discussion icon in the sidebar of the Investigations Guide indicates when small-group discussions should take place. These opportunities also align with the CCSS.ELA SL 4. Describe familiar people, places, things, and events (K-1) recount an experience with appropriate facts and relevant details. At various times during the investigation, students will also ask and answer questions to clarify (K), gather additional information (1st), or deepen understanding (2nd) of information presented orally. (SL2, SL3)

Throughout the activity, the Investigations Guide indicates where it is appropriate to pause for whole-class discussions to guide conceptual understanding. The Investigations Guide provides you with discussion questions to help stimulate student thinking and support sense making. At times, it may be beneficial to use sentence frames or standard prompts to scaffold the use of effective language functions and structures. Younger students can also benefit from modeling and practicing the type of language structures and vocabulary needed to communicate science and engineering ideas effectively.

At the end of the investigation, there is another opportunity to develop oral discourse skills. During the Wrap-Up/Warm-Up, students discuss their responses to the focus question and extend their understanding by
connecting what they are learning to crosscutting concepts, their prior knowledge and experiences, and/or to new ideas. This is a great time to practice discussion protocols and structures such as think-pair-share, attentive listening, or hand-signals, and to discuss norms and expectations.

On the following pages are some suggestions for providing structure to those discussions and for scaffolding productive discourse when needed. Teaching techniques used to generate discussion in language arts and other content areas can also be used effectively during science. Using the protocols that follow will ensure inclusion of all students in discussions.

**Partner and Small-Group Discussion Protocols**

First and foremost, give students time to talk with a partner or in a small group before conducting a whole-class discussion. This provides all students with a chance to formulate their thinking, express their ideas, practice using the appropriate science vocabulary, and receive input from peers. Listening to others communicate different ways of thinking about the same information from a variety of perspectives helps students negotiate the difficult path of sense making for themselves.

**Dyads.** Students pair up and take turns either answering a question or expressing an idea. Each student has 1 minute to talk while the other student listens. While student A is talking, student B practices attentive listening. Student B makes eye contact with student A, but cannot respond verbally. After 1 minute, the roles reverse.

Here’s an example from the **Solids and Liquids Module** (grade 2). Just before students answer the focus question in their notebooks, you ask students to pair up and take turns sharing their answer to the question “Is toothpaste a solid or a liquid?” The science and language learning target is for students to be able to justify their conclusions based on their observations and evidence from previous investigations (orally and in writing) that toothpaste is a mixture. A “claims and evidence” sentence frame can be written on the board to scaffold student thinking and conversation.

- I think <claim> because <the evidence>.

**Partner parade.** Students form two lines facing each other. Present a question, an idea, an object, or an image as a prompt for students to discuss. Give students 1 minute to greet the person in front of them and discuss the prompt. After 1 minute, call time. Have the first student in one of the lines move to the end of the line, and have the rest of the students in that line shift one step sideways so that everyone has a new partner. (Students in the other line do not move.) Give students a new prompt to discuss for 1 minute with their new partners.
For example, students are just beginning the investigation on weather conditions from the **Air and Weather Module** (grade 1), and you want to assess prior knowledge. Give each student a picture of a weather condition (storms, clouds, rain, snow, wind, etc.) and have students line up facing each other. For the first round, ask, “What do you think is happening in the photograph?” For the second round, ask, “What is your experience with this type of weather?” For the third round, ask, “What questions do you have?” The science and language learning target is for students to describe their observations, reflect on their own experiences with different types of weather conditions, and to ask questions about weather. The following sentence frames can be used to scaffold student discussion.

- I notice ___.
- It reminds me of ___.
- I wonder ___

**Put in your two cents.** For small-group discussions, give each student two pennies or similar objects to use as talking tokens. Each student takes a turn putting a penny in the center of the table and sharing his or her idea. Once all have shared, each student takes a turn putting in the other penny and responding to what others in the group have said. For example,

- I agree (or don’t agree) with _____ because _____.

Here’s an example from the **Pebbles, Sand, and Silt Module** (grade 2). Students have been exploring where sand comes from and are still wrestling with the idea that sand is small particles of rock. The science and language learning target is for students to describe their observations, explain how a boulder and a piece of sand can be different sizes of the same rock and provide evidence based on their own prior knowledge. You give each student two pennies, and in groups of four, they take turns putting in their two cents. For the first round, each student answers the question “Where does sand come from?” They use the frame:

- I think sand comes from ____.
- My evidence is ____.

On the second round, each student states whether he or she agrees or disagrees with someone else in the group and why, using the sentence frame. For kindergartners and first graders, you might want to start with just one round and use a “talking stick” or some other object for students to pass to each other to keep track of whose turn it is to speak.
Whole-Class Discussion Supports

- *Sentence frames*
- *Guiding questions*

### Whole-Class Discussion Supports

The whole-class discussion is a critical part of sense making. After students have had the active learning experience and have talked with their peers in partners and/or small groups, sharing their observations with the whole class sets the stage for developing conventional explanatory models. Discrepant events, differing results, and other surprises are discussed, analyzed, and resolved. It is important that students realize that science is a process of finding out about the world around them. This is done through asking questions, testing ideas, forming explanations, and subjecting those explanations to logical scrutiny. Leading students through productive discussion helps them connect their observations and the abstract symbols (words) that represent and explain those observations. Whole-class discussions also provide opportunities for you to prompt student thinking with questions and to interject missing pieces of information they may need to consider to come to accurate conclusions. You might also need to model the kind of discourse and thinking processes you expect from your students. Facilitating effective whole-class discussions takes skill, practice, a shared set of norms, and patience. In the long run, students will have a better grasp of the content and will be better at thinking independently and communicating more effectively. See the Sense-Making Discussions for Three-Dimensional Learning chapter for additional resources.

Norms should be introduced, modeled, and practiced so that students know what is expected during science discussions. Start with one or two at a time and be sure to discuss why norms are important and have students reflect on how well they adhere to them.

- We stay on the topic of science.
- Everyone participates.
- We share our own ideas and experiences and respect those of others.
- We explain our ideas.
- We ask others to explain or repeat if we don’t understand.

The same discussion techniques used during ELA and other whole-class discussions can be used during science instruction (e.g., attentive listening, staying focused on the speaker, asking questions, responding appropriately). In addition, in order for students to develop and practice their reasoning skills, they need to know the language forms and structures and the behaviors used in argumentation [e.g., using data to support claims, disagreeing respectfully, asking probing questions (Winokur and Worth, 2006)].

**TEACHING NOTE**

Let students know that scientists change their minds based on new evidence. It is expected that students will revise their thinking based on evidence presented in discussions.
Explicitly model and conduct mini-lessons (5 to 10 minutes of focused instruction) on the language structures appropriate for active discussions, and provide time for students to practice them, using the science and engineering content.

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

- I think ______, because ______.
- I predict ______, because ______.
- I claim ______; my evidence is ______.
- I agree with ______ that ______.
- My idea is similar/related to ______’s idea.
- I learned/discovered/heard that ______.
- <Name> explained ______ to me.
- <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 ______.

**Guiding questions.** The *Investigations Guide* provides questions to help concentrate student thinking on the concepts introduced in the investigation. Guiding questions should be used during the whole-class discussion to facilitate sense making. Here are some other open-ended questions that help guide student thinking and promote discussion.

- What did you notice when ______?
- What do you think will happen if ______?
- How might you explain ______? What is your evidence?
- What connections can you make between ______ and ______?

If you are having trouble understanding or following a student’s line of thinking, ask questions like:

- Can you say more about that?
- Can someone else respond to what <Name> just said?
- Are you saying ______?
Whole-Class Discussion Protocols

The following examples of tried-and-true participation protocols can be used to enhance whole-class discussions during science and all other curriculum areas. The purpose of these protocols is to increase meaningful participation by giving all students access to the discussion, allowing students time to think (process), and providing a context for motivation and engagement.

**Think-pair-share.** When asking for a response to a question posed to the class, allow time for students to think silently for a minute. Then, have students pair up with a partner to exchange thoughts before you call on a student to share his or her ideas with the whole class. Variations include having one partner paraphrase what the other said or giving students the option of sharing what their partner said.

**Pick a stick.** Write each student's name on a craft stick, and keep the sticks handy at the front of the room. When asking for responses, randomly pick a stick, and call on that student to start the discussion. Continue to select sticks as you continue the discussion. Your name can also be on a stick in the cup. You can put the selected sticks in a different location or back into the same cup to be selected again.

**Whip around.** Each student takes a quick turn sharing a thought or reaction. Questions are phrased to elicit quick responses that can be expressed in one to five words (e.g., “Give an example of a type of tree.” “What are some things that make a sound?”).

**Group posters.** Have small groups design and graphically record their investigation data, their models, or conclusions on a quickly generated poster to share with the whole class.

**Hand signals.** Nonverbal signals can be used to encourage all class participation in discussions. For example, students can show with their hands whether they agree or disagree with a statement, if they want to add on to an idea, or if they have a question. Be sure to model how to use signals appropriately so they are not a distraction for the student speaking.
WRITING STRAND

Information processing is enhanced when students engage in informal writing. When allowed to write expressively without fear of being scorned for incorrect spelling or grammar, students are more apt to organize and express their thoughts in different ways that support sense making. Writing in science promotes the use of science and engineering practices, thereby developing a deeper engagement with the disciplinary core ideas and the crosscutting concepts. This type of informal writing also provides a springboard for more formal derivative science writing (Keys, 1999).

Science Notebooks

The science notebook is an effective tool for enhancing learning in science and developing writing skills. Notebooks provide opportunities both for expressive writing and drawing (students craft explanatory narratives and pictures that make sense of their science experiences) and for learning and practicing informal technical writing (students use organizational structures and writing conventions). Starting as emergent writers in kindergarten, students learn to communicate their thinking in an organized fashion while engaging in the cognitive processes required to develop concepts and build explanations. Having this developmental record of learning provides an authentic means for assessing students’ progress in both scientific thinking and communication skills. Using notebooks also supports the Common Core Writing standards, e.g., students (with guidance K–1) recall information from experiences to answer a question (W8), write (or draw/dictate K) opinions and supply a reason and conclusion (W1), write (or draw/dictate K) explanatory texts with concluding statements (W2), write (or draw/dictate) narratives using event sequence (W3), and develop and strengthen writing with guidance and support from adults (W5).

One way to help students develop the writing skills necessary for productive notebook entries is to focus on the corresponding language functions. The language forms and structures used to perform these language functions in science are used in all curricular areas and, therefore, can be suitably taught in conjunction with existing language-arts instruction. This can be done through mini-lessons on the writing skills that support the various types of notebook entries.

Table 1, at the end of the Writing Strand section, provides examples of how language functions are used to help students develop both their general writing skills and their thinking abilities within the format of the science-notebook entry. The writing objectives for a mini-lesson, along with the particular language forms and structures (vocabulary, syntax, linking words, organization of ideas, and so on), are identified in the table along with the suggested sentence frames for scaffolding.

Science-Centered Language Development in Grades K–2
Science-Centered Language Development in Grades K–2

For example, in the Insects and Plants Module (grade 2) when students are observing a mealworms’ behavior, the literacy-learning target might be “Students use temporal words to describe the behavior of the mealworm.” A prior mini-lesson on using linking words and phrases to describe observations would provide students with the language forms and structures appropriate for recording their data in their notebooks during the observations. As a scaffold, students could also be provided with temporal words and phrases to help them write detailed narratives.

<table>
<thead>
<tr>
<th>Language function</th>
<th>Language objectives for writing in notebooks</th>
<th>Language forms, structures, and scaffolds for writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe</td>
<td>Write narratives to develop real experience; use descriptive details and clear event sequencing. (CCSS.ELA W3)</td>
<td>I observed ___. When I touch the ___, I feel ____ The ___ has ___. I noticed ___. It feels ___. It smells ___. It sounds ___. It reminds me of ___, because _____.</td>
</tr>
</tbody>
</table>

This sample from Table 1 shows how language functions can be developed and applied when writing in science notebooks.

Developing Derivative Language-Arts Products

Science notebooks provide students with a source of information (content) from which they can draw to create more formal science-centered writing pieces. Derivative products are written pieces that are generated with specific language-arts goals in mind, such as purpose, text types, and audience. Writing-to-learn methods can enhance science concepts when students engage in different types of writing for different purposes (Hand and Prain, 2002). We know that students are more engaged and motivated to write when they have a clear and authentic context for writing.

The language extensions in the Interdisciplinary Extensions section at the end of each investigation suggest writing activities that can be used to help students learn the science content for that particular investigation. The writing activities incorporate language-arts skills appropriate for the grade level. Questions and ideas for future writing activities that surface during the investigations can be recorded in a class list, in science notebooks, or in students’ writing folders. Here are general suggestions for using science content to create products in each of several writing genres including those addressed in the Common Core for English Language Arts (CCSS.ELA).
**Argumentation Writing**

The CCSS for ELA define an argument as a reasoned, logical way of demonstrating that the writer’s position, belief, or conclusion is valid. In science, students make claims in the form of statements or conclusions that answer questions or address problems. Using data in a scientifically acceptable form, students marshal evidence and draw on their understanding of scientific concepts to argue in support of their claims. Across the disciplines, students write arguments to either 1) change a point of view, 2) bring about some type of action, or 3) put forth an explanation or evaluation of a concept, issue, or problem. For K–5 students, this type of writing is called an “opinion piece.” The term “opinion” is used to refer to a developing form of argument (CCSS for ELA/Literacy Appendix A). For grades K–2, students introduce a topic or text, state an opinion (K), and supply a reason for the opinion and provide a conclusion (1–2).

Engaging in argument from evidence in the FOSS investigations supports this type of writing. Use the questions and prompts in the Investigations Guide that encourage students to use their observations, models, and information from the text or multimedia to support both their oral and written arguments. In addition, be prepared for those teachable moments that provide the perfect stage for spontaneous scientific debate. Here are some general questions to help students strengthen their argumentation writing.

- Why do you think that ___?
- Do you agree or disagree with ___? Why?
- Which do you think is better? Why?
- Why was it better that ___?

Following are more ways engaging in written argument are developed in the FOSS investigations and can be extended through formal writing.

**Answer the focus question.** When answering the focus question, students make a claim (or state their opinion) and provide evidence to support their claim based on their observations from the investigation and patterns they can identify. This is usually in the form of “I think _____ (claim) because ______ (evidence).” Students can revisit their responses, add a line of learning, and revise their claim or add new evidence. For formal writing, have students use the information from their notebooks to expand on their response in a more polished opinion piece that includes more detailed illustrations, linking words, and a concluding statement. (W1)

**Thinking about questions.** Interactive reading in FOSS Science Resources is another opportunity for students to engage in written argumentation. Articles include questions that support reading comprehension and extend student thinking about the science content. Asking students to make a claim and provide evidence to support it, encourages the use of language...
functions necessary for higher-level thinking such as evaluating, applying, and justifying. For example, in the **Sound and Light** FOSS Science Resources (grade 1), students are asked to think about reflections. *How is a shadow different from a reflection?*

**I-Checks and Surveys/Posttests (grades 1–2).** Included in the assessments are items that assess students’ ability to make a claim and provide evidence to support it. One way is to provide students with data and have them make a claim based on that data and evidence from their prior investigations. Their argument should use logical reasoning to support their ideas. For example, in the **Pebbles, Sand, and Silt Module** (grade 2) students are presented with two ways to make sand castle towers. Based on their experiences with sand and matrix, they predict what will happen to the two structures.

**Persuasive writing.** Opportunities to practice writing in their notebooks builds the foundation for the more formal writing students will be asked to do in the upper grades. Students learn to record their observations, explain, and apply their emerging science knowledge. Sharing their writing and drawings with an audience also motivates students to produce higher-level writing products. The objective of persuasive writing is to convince the reader that a stated interpretation of data is worthwhile and meaningful. Students learn to support their claims with evidence and how to use persuasive techniques such as a call to action. Through interactive, shared, or scaffolded independent writing students can draw on the information from their investigations to jointly craft persuasive writing in a variety of formats, such as, posters, letters, advertisements, informational pamphlets, and petitions. Animal habitats, energy use, weather patterns, landforms, and water sources are just a few science topics that can generate questions and issues for persuasive writing.

Here is an example of a persuasive writing frame for an opinion piece,

We think that _____.

The reasons are _____ and _____.

For these reasons we think _____.

**Informative/Explanatory Writing**

Informational and explanatory writing requires students to examine and convey ideas and information clearly. Described in CCSS, ELA Appendix A, informational/explanatory writing answers the questions, *What type? What are the parts? What are the properties, functions, and behaviors? How does it work? What is happening? Why?* In FOSS, this type of writing takes place informally in science notebooks, where students are recording their questions, plans, procedures, data, models,
and explanations. It also supports sense making as students attempt to convey what they know in response to questions and prompts, using language functions such as identifying, comparing and contrasting, explaining cause-and-effect relationships, and sequencing.

During writing instruction, students can use the information in their science notebooks and in related readings (and other sources, such as video content) to write a more formal and conclusive answer to the focus question in the form of an explanatory text by introducing a topic, using facts and definitions to develop points, and providing a concluding statement (W2).

Students can also apply their science knowledge to inform, explain, clarify, define, or instruct through writing letters, definitions, procedures, newspaper and magazine articles, blogs, posters, pamphlets, and research reports. Strategies such as the writing process (plan, draft, edit, revise, and share) and writing frames (modeling and guiding the use of topic sentences, transition and sequencing words, examples, explanations, and conclusions) can be used to scaffold and help students develop proficiency in informative/explanatory writing.

Here are two samples of writing frames.

**Living Structures**
Title: _____
(Identify) The parts of the _____ I observe are the _____, _____, and the _____.
(Describe) The _____ is for _____. The _____ is for _____.
(Explain) Together, they _____.
(Example) This drawing shows _____.

**Explanations**
Title: _____
I want to explain why (how) _____.
The reason is _____.
Another reason is that _____.
I know this because _____.

TEACHING NOTE
When students use organisms for scientific informational writing, have a conversation about the difference between fiction and nonfiction, e.g., animals don’t talk or drive cars.
Narrative Writing

Narrative writing conveys an experience to the reader, usually with sensory detail and a sequence of events. In science, kindergarteners use a combination of drawing, dictating, and writing to narrate what they did and observed during the investigation in the order in which they occurred and their reaction. Second and third graders include more and more detail, describe actions, use temporal words, and provide a sense of closure. Writing and drawing routinely in their notebooks allows students to practice this type of writing informally. They can also use the context of the FOSS investigations to write more formal narrative pieces to describe the sequence of events and their thoughts and feelings (CCSS.ELA W3).

Science provides a broad landscape of engaging material for stimulating the imagination for the writing of stories, songs, chants, poems, and skits. Students can use organisms or objects as characters; describe habitats and environments as settings; and write scripts portraying various systems, such as weather patterns, the story of a rock, or life cycles.

Descriptive writing. Students use descriptive writing to portray an organism, an environment, an object, or a phenomenon. They learn to use sensory language and vivid and lively details.

To help them extend their learning of the disciplinary core ideas, students can use the information in their science notebooks to elaborate on their observations by using descriptive vocabulary, temporal words and phrases, and drawing.

Kindergarteners can dictate their observations or contribute to a class notebook describing animals, trees, landforms, wood, etc.

First and second graders can make property cards by writing on an index card as many properties as they can that describe an object or organism. Then, students take turns reading the properties to another student to see if the partner can identify the corresponding object.

**NOTE**

Human characteristics should not be given to organisms (anthropomorphism) in science investigations, only in literacy extensions.
Table 1. Examples of how language functions are exercised in science notebook writing and examples of sentence frames and language structures teachers can model and students may use as they develop their writing skills

<table>
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<th>Language objectives for writing in notebooks</th>
<th>Language forms, structures, and scaffolds for writing</th>
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</thead>
<tbody>
<tr>
<td><strong>Organizational setup</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organize</td>
<td>Set up and organize notebook: table of contents (for grade 2), page numbers, date, turning to the next blank page.</td>
<td>Model using a classroom notebook. Use structures such as rows, columns, blocks, numbers, location, alphabetizing.</td>
</tr>
<tr>
<td><strong>Notebook component—planning the investigation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Strategize</td>
<td>Write a narrative plan: communicate ideas on an approach to answer the focus question or challenge posed in the investigation.</td>
<td>Use adverbs such as first, second, next, then, finally. Brainstorming ideas: First I will ____, and then I will ____. I will need to ____ to ____</td>
</tr>
<tr>
<td>List Record</td>
<td>Write ordered lists: materials, variables, vocabulary words, bullets</td>
<td>We need ____, ____, ____ and ____ to ____.</td>
</tr>
</tbody>
</table>
| Sequence          | Record procedures: number steps in a sequence. | 1. ________________ .
|                   |                                           | 2. ________________ .
|                   |                                           | 3. ________________ .
|                   |                                           | I will observe ____.
|                   |                                           | I will measure ____ |
| **Notebook component—data acquisition** |                                             |                                                      |
| Describe          | Write narratives: use details, sensory observations, connections to prior knowledge. | I observed ____. When I touch the ____ I feel ____. The ____ has ____. I noticed ____. It feels ____. It smells ____. It sounds ____. It reminds me of ____, because ____.

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<table>
<thead>
<tr>
<th>Language function</th>
<th>Language objectives for writing in notebooks</th>
<th>Language forms, structures, and scaffolds for writing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Notebook component—data acquisition</strong> (continued)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Draw                    | Make technical drawings: draw large, accurate, and detailed representations; identify parts of a system.    | Label drawing, using science vocabulary.  
Recognize shapes, form, location, color, size, and scale.  
My drawing shows ___.       |
| Label                   |                                                                                                              |                                                                                                                  |
| Identify                |                                                                                                              |                                                                                                                  |
| Organize                | Make charts and tables: use a T-table or chart for recording and displaying data.                           | Set up rows, columns, headings.                                                                                   |
| Compare                 |                                                                                                              | My T-table compares ___.                                                                                         |
| Classify                |                                                                                                              |                                                                                                                  |
| Sequence                | Record changes: use language structures to communicate change over time, cause and effect.                   | At first, ___, but now ___.  
We saw that first ___, then ___, and finally ____.  
When I ___, it _____.  
After I ___, it _____. |                                                                                                                  |
| Compare                 |                                                                                                              |                                                                                                                  |
| Classify                |                                                                                                              |                                                                                                                  |
| Sequence                |                                                                                                              |                                                                                                                  |
| **Notebook component—data organization**                                                        |                                                                                   |                                                                                                                  |
| Enumerate               | Decide when to use qualitative vs. quantitative data; use counting and numbers to identify patterns; describe, measure, and compare quantitative attributes of different objects; display data using simple graphs. | We counted ___.  
We measured ___.  
There are more/less ___.  
The ___ is bigger/smaller ___.  
We found out that ___.  
The graph/table shows ___. |
| Compare                 | Use graphic organizers and narratives to express similarities and differences, to assign an object or action to the category or type to which it belongs, and to show sequencing and order. | This ___ is the same as ___, because ___.  
This ___ is different than ___, because ___.  
All these are ___ because ___,  
___, ___ and ___ all have/are ___. |
| Classify                |                                                                                                              |                                                                                                                  |
| Sequence                |                                                                                                              |                                                                                                                  |
| **Analyze**             | Use graphic organizers, narratives or concept maps to identify part/whole or cause-and-effect relationships. | Use relationship verbs such as are made of, are part of.  
As ___, then ___.  
When I changed ___, then ___ happened.  
The more/less ___, then ___ |                                                                                                                  |
Table 1 (continued)

<table>
<thead>
<tr>
<th>Language function</th>
<th>Language objectives for writing in notebooks</th>
<th>Language forms, structures, and scaffolds for writing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Notebook component—sense-making</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infer</td>
<td>Provide claims and evidence: write conclusions about what was learned from the investigation, use the data (observations) as evidence to support those claims.</td>
<td>Use inferential logical connectors such as but, even though. I claim that ____. I know this because _____.</td>
</tr>
<tr>
<td>Explain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide evidence</td>
<td>Use qualitative and quantitative data from the investigation as evidence to support claims.</td>
<td>Use qualitative descriptors such as more/less, longer/shorter, higher/lower. Use quantitative expressions using standard metric units of measurement such as cm. I measured ____. I observed ____.</td>
</tr>
<tr>
<td>Summarize</td>
<td>Write a summary narrative to communicate what was learned; ask questions and make predictions based on the newly acquired knowledge.</td>
<td>Answer the focus question by rewriting it as a statement and providing evidence from observations. Make a concluding statement. I learned ____. I think _____. I predict _____. because ____.</td>
</tr>
<tr>
<td>Predict</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generalize</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notebook component—next-step strategies**

<table>
<thead>
<tr>
<th>Language function</th>
<th>Language objectives for writing in notebooks</th>
<th>Language forms, structures, and scaffolds for writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critique</td>
<td>Reflect on experience: review notebook entries and revise, use line of learning to revise.</td>
<td>I used to think ____, but now I think ____. I have changed my thinking about ____. I am confused about ____ because ____. I wonder _____.</td>
</tr>
<tr>
<td>Evaluate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
READING STRAND

Reading is an integral part of science learning. Just as scientists spend a significant amount of their time reading one another’s published works, students need to learn to read scientific text—to read effectively for understanding with a critical focus on the ideas being presented.

The articles in *FOSS Science Resources* help facilitate sense making as students make connections to the science concepts introduced and explored during the active investigations. Concept development is most effective when students are allowed to experience organisms, objects, and phenomena firsthand before engaging the concepts in text. The text and illustrations help students make connections between what they have experienced concretely and the abstract ideas that explain their observations.

*FOSS Science Resources* supports developing literacy skills by providing reading material that corresponds exactly to the concrete, personal experience provided in the active investigations. Students read with enthusiasm when they recognize familiar materials, organisms, and activities and are eager to tackle the reading to confirm their prior knowledge and discover more about the topic. In addition to making connections, once engaged, students naturally use other reading-comprehension strategies, such as asking questions, visualizing, inferring, and synthesizing, to help them understand the reading. As students apply these strategies, they are, in effect, using some of the same scientific thinking processes that promote critical thinking and problem solving.

Learning to Read Informational Texts

In the kindergarten modules, you can enhance science learning by using trade books and other read-aloud resources to engage students and provide topics for lively discussions. Reading aloud helps primary students understand the science content and lets you model reading comprehension strategies, such as asking yourself questions (thinking aloud) and summarizing a paragraph just read. The reading in *FOSS Science Resources* sections offer suggestions for activating prior knowledge before reading, indicate places to pause and discuss key points during the reading, and describe activities to deepen understanding after the reading. As students develop their reading skills, you might try these different ways to read from *FOSS Science Resources*.

- Read aloud from the big book while students follow along in their own books.
- Lead students in small guided reading groups.
- Have students read aloud with a partner.
- Have students read silently on their own.
The same strategies used in language arts to address the CCSS.ELA RI 10 can be applied to reading in science. Kindergartners are actively engaged in group reading activities to find out more about their science investigations; first graders begin to access the complex text found in the FOSS Science Resources articles with prompting and support; and second graders read and comprehend the articles with scaffolding as needed (CCSS.ELA RI 10).

**Build on background knowledge.** Activating prior knowledge is critical for helping students make connections between what they already know and new information. Reading comprehension improves when students have the opportunity to think about and discuss what they know about a topic before reading. Review what students learned from the active investigation, provide prompts for making connections, and ask questions to help students recall past experiences and previous exposure to concepts related to the reading. Ask students to discuss the photographs and diagrams and how they relate to the written text. They should ask themselves: What do I know about this picture? What don't I know? What does it remind me of? I wonder... As they listen to or read the text on their own, remind them to think back on their original interpretations to see if they match those of the author.

**Model close reading.** Begin with reading the article aloud so that students can hear the content read fluently and listen for meaning and coherence. Go back and review the questions and prompts within the article. Use think-pair-share or other discussion protocols to allow students to think first, share with a partner, and then respond to the group. For kindergartners and beginning readers, emphasize blending phonemes as you read the text again, and model tracking, connecting spoken words with written words, and helping students identify sight words. Model reading-comprehension strategies by using think-alouds (as you think aloud, you explain the process that you are using in order to understand the text while reading).

**Examine craft and structure.** The expository text structure of the articles provides the opportunity for primary students to learn how to extract information from a table of contents, a glossary, an index, and other text conventions such as headings, subheads, boldface and italic print, labeled graphics, and captions. (CCSS.ELA R1 5 know and use text features.) They can also practice asking and answering questions to clarify word meanings (RI 4 K–1) and use strategies for determining the meaning of unknown words and phrases such as sentence level context clues, prefixes and root words, and glossaries (RI 4 and L4 grade 2).
Building reading comprehension skills. When appropriate, use the articles to point out and discuss with students important features to consider when reading informational text, such as how the illustrations relate to and help them to understand the key ideas in the articles (CCSS. ELA RI 7) and the reasons the author gives to support specific points (RI 8). Students can also compare the information in the FOSS Science Resources book articles with other texts of the same topic (RI 9). At the end of articles, use the questions provided to guide understanding and to assess comprehension and vocabulary acquisition. For second graders you might choose one or two questions for them to answer in their notebooks. Emphasize the importance of science vocabulary and the appropriate language forms and structures. Here are some ways students can enhance reading comprehension.

- Have students predict the sequence of events or content.
- Have students write or dictate questions about the text and illustrations.
- Use visualization with students to “see, touch, feel, smell, hear” in their minds the content presented in the article.
- Ask students to make connections between their observations during the active investigation and the information in the article.
SCIENCE- VOCABULARY DEVELOPMENT

Words play two critically important functions in science. First and most important, we play with ideas in our minds, using words. We present ourselves with propositions—possibilities, questions, potential relationships, implications for action, and so on. The process of sorting out these thoughts involves a lot of internal conversation, internal argument, weighing of options, and complex linguistic decisions. Once our minds are made up, communicating that decision, conclusion, or explanation in writing or through verbal discourse requires the same command of the vocabulary. Words represent intelligence; acquiring the precise vocabulary and the associated meanings is key to successful scientific thinking and communication.

The words introduced in FOSS investigations represent or relate to fundamental science concepts and should be taught in the context of the investigation. Many of the terms are abstract and are critical to developing science content knowledge and scientific and engineering practices. The goal is for students to use science vocabulary in ways that demonstrate understanding of the concepts the words represent—not to merely recite scripted definitions. The most effective science-vocabulary development strategies help students make connections to what they already know. These strategies focus on giving new words conceptual meaning through experience; distinguishing between informal, everyday language and academic language; and using the words in meaningful contexts.

Building Conceptual Meaning through Experience

In most instances, students should be presented with new words in the context of the active experience at the need-to-know point in the investigation. Words such as vibration, weathering, dissolve, evaporate, variation, and larva are conceptually loaded and significantly abstract. Students will have a much better chance of understanding, assimilating, and remembering the new word (or new meaning) if they can connect it with a concrete experience.
The new-word icon appears in the sidebar when you introduce a word that is critical to understanding the concepts or scientific practices students will be learning and applying in the investigation. When you introduce a new word, students should

- **Hear it**: Students listen as you model the correct contextual use and pronunciation of the word.
- **See it**: Students see the new word written out. Add a visual reference (an illustration or a sample) next to the word if possible.
- **Say it**: Have students say the word chorally and clap out the syllables.
- **Write it**: You write the word on the board, chart paper, sentence strip, or card. Students use the new words in context when they write in their notebooks.
- **Act it**: Demonstrate action words such as separate, compare, and observe (using total physical response).

### Bridging Informal Language to Science Vocabulary

Students bring a wealth of language experience to the classroom. FOSS investigations are designed to tap into students’ inquisitive natures and their excitement of discovery in order to encourage lively discussions as they explore materials in creative ways. There should be a lot of talking during science time! Your role is to help students connect informal language to the vocabulary used to express specific science concepts.

As you circulate during active investigation, you continually model the use of science vocabulary. Following are some strategies for validating students’ conversational language while developing their familiarity with and appreciation for science vocabulary.

**Word bubbles.** Choose a word from the word wall that is widely used by students and that is a synonym for a science vocabulary word. Draw a circle on the board or chart paper, and write the word in the center. Draw lines out from the circled word, and make more circles. Ask students to call out more synonyms for the word, and write them in the outer circles. Introduce the target vocabulary word as yet one more synonym for the target word, a word that is used in science. Highlight the word, and model its correct usage and pronunciation. Encourage students to use it in their discussions and in their notebook entries. Introduce the science word that is its opposite, when appropriate.

**Word sorts.** Make a set of word cards from words on the word wall. Ask students to help you group the words that are synonyms or that have conceptual connections. Add the new science words to the card set. Repeat the process with a new set of words. For advanced students, make sets of vocabulary cards for them to sort with a partner or in small groups.
Semantic webs. Select a vocabulary word, and write it in the center of a piece of paper (or on the board if doing this with the whole class). Brainstorm a list of words or ideas that are related to the first word. Group the words and concepts into several categories, and attach them to the central word with lines, forming a web (modified from Hamilton, 2002).

Concept maps. Select six to ten related science words and write them on self-stick notes or cards. Place them on the board and have students help you organize them into groups. When the class agrees on a way to organize the words, draw lines between the related words. On the lines, write connecting words that describe or explain how the concept words are related. Once students are familiar with the process they can work together in small groups to make their own concept maps.

Cognitive content dictionaries. There are a variety of frameworks to help students record their learning of new words. This example can be used with the whole class or individually to introduce a few key vocabulary words used in an investigation. Write the word on the board or chart paper, ask students to predict its meaning, write the final meaning after class discussion, and then use the word in a sentence. The word can also be used as a signal word to call for attention.

<table>
<thead>
<tr>
<th>Cognitive Content Dictionary</th>
</tr>
</thead>
<tbody>
<tr>
<td>New word</td>
</tr>
<tr>
<td>Prediction (clues)</td>
</tr>
<tr>
<td>Final meaning</td>
</tr>
<tr>
<td>How I would use it (sentence)</td>
</tr>
</tbody>
</table>

Word associations. In this brainstorming activity, you say a word, and students respond by sharing the first word that comes to mind. Generate a list of words based on students’ responses. This activity builds connections to students’ prior frames of reference.
Using Science Vocabulary in Context

In order for a new vocabulary word to become part of a student’s functional vocabulary, he or she must have ample opportunities to hear and use it. The use of vocabulary terms is embedded throughout the entire investigation through discussions, during investigations, writing in science notebooks, readings, assessments, interactive media, and games. In addition, other methods used during language-arts instruction can be used to reinforce important vocabulary words and phrases.

**Word wall/word cards.** Use chart paper or a pocket chart to record both science content and procedural words. Record the words as they come up during and after the investigations. Then copy key words on sentence strips or cards, and put them in a pocket chart. With a pocket chart, words can be sorted and moved around easily. For example, you could ask students to find words that are synonyms, antonyms, nouns, or verbs. Word cards should be available to each group during the investigation. This allows students to retrieve a word quickly when they are labeling diagrams and objects used during the investigation.

**Drawings and diagrams.** For English learners and visual learners, a diagram can be used to review and explain abstract content. Ahead of time, draw an illustration lightly, almost invisibly, with pencil on chart paper. When it’s time for the investigation, trace the illustration with markers as you introduce the words and phrases to students. Students will be amazed by your artistic ability.

**CCSS NOTE**
These strategies address the CCSS for ELA Language Strand, Vocabulary Acquisition and Use, 4-6.

- L4  Determine the meaning of unknown words and phrases
- L5  Demonstrate understanding of word relationships and nuances
- L6  Use acquired words and phrases
**Cloze activities.** Structure a sentence for students to complete, leaving out the vocabulary word, and crafting the sentence so that the missing vocabulary word is the last word in the sentence. You can do this chorally or in writing on the board or chart paper. Here’s an example from the **Solids and Liquids Module**.

Teacher: **Liquids that are clear and that you can see through are _____.

Students: **Transparent.

**Word wizard.** Tell students that you are going to lead a word activity. You will be thinking of a science vocabulary word from the word wall. The goal is to figure out the word. Provide hints that have to do with parts of a definition, root word, prefix, suffix, and other relevant components. Students work in teams of two to four. Provide one hint, and give teams 1 minute to discuss. One team member writes the word on a piece of paper or on the whiteboard, using dark marking pens. Each team holds up its word for only you to see. After the third clue, reveal the word, and move on to the next word.

1. **This word is part of a plant.**
2. **It is usually not green.**
3. **It brings water and nutrients into the plant.**

   It is the **root**.

**Word analysis/word parts.** Learning clusters of words that share a common origin can help students understand content-area texts and connect new words to familiar ones. This type of contextualized teaching meets the immediate need of understanding an unknown word while building generative knowledge that supports students in figuring out difficult words for future reading.

- geology
- geologist
- geological
- geography
- geometry
- geophysical
Reading. After the active investigation, students continue to develop their understanding of the vocabulary words and the concepts those words represent by listening to you read aloud, reading with a partner, or reading independently. Use strategies discussed in the Reading Informational Texts section to encourage students to articulate their thoughts and practice the new vocabulary.

Games. The informal activities included in the investigations are designed to reinforce important vocabulary words. Once students learn them, the words can be integrated into any type of independent work time, such as centers, workshops, and early-finisher tasks.
Active investigations provide an optimal learning environment for English learners (ELs) to develop and use language in meaningful ways. This section highlights the English-language development (ELD) opportunities inherent in the FOSS lesson design and suggests additional scaffolds, modifications, and linguistic accommodations that support student engagement in the science and engineering practices as well as the development of academic literacy. Our starting point is the hands-on collaborative structure of FOSS investigations, which is essential for both the conceptual development of science content knowledge and the habits of mind that guide and define the science and engineering practices. Students are engaged in concrete experiences with phenomena and challenging tasks that provide a shared context for interacting in meaningful ways to developing understanding—a critical component for developing language proficiency. The WIDA (World-class Instructional Design and Assessment) and ELP Standards (English Language Proficiency Standards with Correspondences to the K-12 Practices and Common Core State, Council of Chief State School Officers) and other similar state standards all stress the importance of engaging ELs in authentic, meaningful, and rigorous tasks that require constructing meaning through collaborative exchanges of information. The ELPS are organized into three modalities of communication receptive (listening and reading); productive (speaking and writing); and interactive (collaboration using receptive and productive).

Another critical component for ELD in science is strategic scaffolding—both planned and “just-in-time.” To address the needs of English learners, the Investigations Guide includes EL notes at points in the investigations where students at beginning levels of English proficiency may need additional supports. When getting ready for an investigation, review the EL notes, and determine the points where differentiated instruction for ELs is needed or where the whole class might benefit from additional language development supports. It is helpful to consider these needs in terms of all three modes of communication—receptive, productive, and interactive. In other words, ask yourself, What will be challenging for my students when listening to others and reading the FOSS Sciences Resources? What kind of support will they need to write a response to the focus question or to speak in the sense-making discussion? How will I make sure students are including everyone in their small-group tasks?

**NOTE**

English-language development refers to the advancement of students’ ability to read, write, and speak English.

**NOTE**

See Table 1 for ways that the FOSS Instructional design provides opportunities to address the WIDA and ELPS.
One way to plan for ELD integration and science instruction is to keep in mind four key areas: activating students’ prior knowledge, ensuring comprehensible input, developing academic language, and providing for oral practice. The ELD chart below lists examples of universal strategies for each of these areas that are effective for science instruction for ELs and align with the WIDA, ELPS, and other state standards.

<table>
<thead>
<tr>
<th>English-Language Development (ELD) Quadrants</th>
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</thead>
<tbody>
<tr>
<td><strong>Activating prior knowledge</strong></td>
</tr>
<tr>
<td>• Inquiry chart</td>
</tr>
<tr>
<td>• Circle map</td>
</tr>
<tr>
<td>• Observation poster</td>
</tr>
<tr>
<td>• Quick write</td>
</tr>
<tr>
<td>• Kit inventory</td>
</tr>
<tr>
<td><strong>Using comprehensible input</strong></td>
</tr>
<tr>
<td>• Content objectives</td>
</tr>
<tr>
<td>• Multiple exposures</td>
</tr>
<tr>
<td>• Visual aids</td>
</tr>
<tr>
<td>• Supported reading</td>
</tr>
<tr>
<td>• Procedural vocabulary</td>
</tr>
<tr>
<td><strong>Developing academic language</strong></td>
</tr>
<tr>
<td>• Language objectives</td>
</tr>
<tr>
<td>• Sentence frames</td>
</tr>
<tr>
<td>• Word wall, word cards, drawings</td>
</tr>
<tr>
<td>• Concept maps</td>
</tr>
<tr>
<td>• Cognitive content dictionaries</td>
</tr>
<tr>
<td><strong>Providing oral practice</strong></td>
</tr>
<tr>
<td>• Small-group discussions</td>
</tr>
<tr>
<td>• Science talk</td>
</tr>
<tr>
<td>• Oral presentations</td>
</tr>
<tr>
<td>• Poems, chants, and songs</td>
</tr>
<tr>
<td>• Teacher feedback</td>
</tr>
</tbody>
</table>

### Activating Prior Knowledge

When an investigation presents a new phenomenon or concept, first students recall and discuss familiar situations, objects, or experiences that relate to and establish a foundation for building new knowledge and conceptual understanding. Eliciting prior knowledge supports learning by motivating interest, acknowledging culture and values, and checking for alternative or incomplete explanations and prerequisite knowledge. This way of engaging students is usually done in the first steps of Guiding the Investigation in the form of an oral discussion or presentation of new materials. The Letter to Family and the Home/School Connection activities also provide opportunities to tap into students’ cultural and linguistic knowledge. In addition, the tools outlined below can be used before beginning an investigation to establish a familiar context for launching into new material.

#### Circle maps.

Draw two concentric circles on chart paper. In the middle circle, write the topic to be explored. In the second circle, record what students already know about the subject. Ask students to think about how they know or learned what they already know about the topic. Record the responses outside the circles.
An example of a circle map

**Magnet**

- Metal things stick to them.
- Magnets stick to refrigerators.
- Magnets are made of metal.
- They’re hard.
- Some materials don’t stick to magnets.
- We have lots of magnets on our refrigerator at home.
- My brother told me they are made of metal.
- When I play with magnets, they stick to metal things.
- We saw a movie about magnets.

**Observation posters.** Make observation posters by gluing or taping pictures and artifacts relevant to the module or a particular investigation onto pieces of blank chart paper or poster paper. Try to include images that relate to students’ cultural and linguistic identities and interests. Hang them on the walls in the classroom, and have students rotate in small groups to each poster. At each station, students discuss their observations with their partners or small groups and then record or dictate an observation, a question, a prediction, or an inference about the pictures as a contribution to the commentary on the poster.

**TEACHING NOTE**

The images selected for the observation posters should pique students’ interest but not take away from discoveries that students will make when working with the materials.
Kit inventories. Introduce each item from the FOSS kit used in the investigation, and ask students questions to get them thinking about what each item is and where they may have seen it before. Have them describe the objects and make predictions about how they will be used in the investigation. Tape samples of the items on chart paper, or print and display the equipment photo cards (download from FOSSweb) along with the name and a description, to serve as an interactive word wall.

<table>
<thead>
<tr>
<th>Item</th>
<th>Teacher</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottle</td>
<td>What is this?</td>
<td>A bottle.</td>
</tr>
<tr>
<td></td>
<td>What is it made of?</td>
<td>Plastic.</td>
</tr>
<tr>
<td></td>
<td>What is it used for?</td>
<td>To hold liquids.</td>
</tr>
<tr>
<td>Scoop</td>
<td>What is this?</td>
<td>It looks like a spoon.</td>
</tr>
<tr>
<td></td>
<td>It’s like a spoon. It’s called a scoop.</td>
<td>Like an ice-cream scoop!</td>
</tr>
<tr>
<td></td>
<td>What do you think we will be using it for in science?</td>
<td>To scoop things up.</td>
</tr>
<tr>
<td>Funnel</td>
<td>Have you seen this before?</td>
<td>My mom uses that for the car.</td>
</tr>
<tr>
<td></td>
<td>It’s called a funnel. Where else have you seen this?</td>
<td>In the kitchen. My uncle uses it sometimes to pour things.</td>
</tr>
<tr>
<td></td>
<td>Can you describe it?</td>
<td>It’s round on the ends. It’s bigger on one end, and it’s hollow.</td>
</tr>
<tr>
<td>Beaker</td>
<td>Have you seen this before?</td>
<td>We used it for science last year to measure and pour water.</td>
</tr>
<tr>
<td></td>
<td>It’s called a beaker. Where else have you seen this?</td>
<td></td>
</tr>
<tr>
<td>Vial</td>
<td>This is a vial. What do you think we will be using it for in science?</td>
<td>To hold small things.</td>
</tr>
</tbody>
</table>

A kit inventory script from the Solids and Liquids Module
Comprehensible Input

In order to initiate their own sense-making process, students must be able to access the information presented to them. We refer to this ability as comprehensible input. Students must understand the essence of new ideas and concepts before beginning the process of constructing new scientific meaning. The strategies for comprehensible input used in FOSS ensure that the delivery of instruction is understandable while providing students with the opportunity to grapple with new ideas and the critically important relationships between concepts. Additional linguistic accommodations such as repetition, visual aids, emphasis on procedural vocabulary, and auditory reinforcement can also be used to convey meaning of key concepts to ELs. (See Table 1. Linguistic supports for kindergarten through second grade organized by proficiency levels.)

Content objectives. The focus question for each investigation part frames the activity objectives—what students should know or be able to do at the end of the part. Together the focus questions help students build a conceptual framework for understanding the overarching anchor phenomenon explored in the module. Making the learning objectives or targets clear and explicit helps English learners prepare to process the delivery of new information, and helps you maintain the focus of the investigation. Write the focus question on the board and read it aloud. At the end of the investigation part, ask students to write or glue in the focus question and write or dictate the response. During the Wrap-Up/Warm-Up you can check their responses for understanding.

Multiple exposures. Repeat the activity as a class, at a center during independent work time, or in an analogous but slightly different context, ideally one that incorporates elements that are culturally relevant to students.

Visual aids. On the board or chart paper, write out and illustrate the steps for conducting the investigation. This will provide a visual reference. Use graphic representations (illustrations drawn and labeled in front of students) to review the concepts explored in the active investigations. In addition to the concrete objects included in the kit, use realia to augment the activity to help English learners build understanding and make cultural connections. Simple graphic organizers (webs, Venn diagrams, T-tables, flowcharts, etc.) aid comprehension by helping students see how ideas (concepts) are related.

ELPS NOTE

These strategies support the ELPS 8–10 and WIDA Standard 4.
Supported reading. In addition to the reading comprehension strategies suggested in the Reading Strand section of this chapter, English learners can also benefit from methods such as front-loading key words, phrases, and complex text structures before reading or using preview-review (main ideas are previewed in the primary language, read in English, and reviewed in the primary language).

Procedural vocabulary. Make sure students understand the meaning of the words used in the directions describing what they should be doing during the investigation. These may or may not be science-specific words. Use techniques such as modeling, demonstrating, and body language (gestures) to explain procedural meaning in the context of the investigation. The words students will encounter in FOSS include those listed in the sidebar. To build academic literacy, English learners need to learn the multiple meanings of these words and their specific meanings in the context of science.

Developing Academic Language
As students learn the nuances of the English language, it is critical that they build proficiency in academic language in order to participate fully in the cognitive demands of school. Academic language refers to the more abstract, complex, and specific aspects of language, such as the words, grammatical structure, and discourse markers that are needed for higher cognitive learning. FOSS investigations introduce and provide opportunities for students to practice using the academic vocabulary needed to access and meaningfully engage with science ideas.

Science language learning objectives. Consider the English proficiency levels of your ELs and incorporate specific language-development objectives that will support their engagement in the science and engineering practices. You might focus on a specific word knowledge skill (a way to expand use of vocabulary by looking at root words, prefixes, and suffixes), a linguistic pattern or structure for oral discussion and writing, or a reading-comprehension strategy. Recording in students’ science notebooks is a productive place to optimize science learning and language objectives.

To help students meet the language demands of practices like constructing explanations and engaging in argument from evidence, first, consider the analytical or cognitive tasks required to meet the language objective. For example, to engage in argument from evidence, students will need to be able to do these things.

Procedural Vocabulary

Add
Analyze
Assemble
Attach
Calculate
Change
Classify
Collect
Communicate
Compare
Connect
Construct
Contrast
Describe
Demonstrate
Determine
Draw
Evaluate
Examine
Explain
Explore
Fill
Graph
Identify
Illustrate
Immerse
Investigate
Label
List
Measure
Mix
Observe
Open
Organize
Pour
Prepare
Predict
Record
Represent
Scratch
Separate
Sort
Stir
Subtract
Summarize
Test
Weigh

ELPS NOTE
These strategies support the ELPS 8–10 and WIDA Standard 4.
• Distinguish between a claim and supporting evidence or explanation.
• Analyze whether expressed evidence supports, contradicts, or is irrelevant to a claim.
• Analyze how well a model (explanation) and evidence are aligned.
• Construct an argument.

To accomplish these analytical tasks, students will use both receptive and productive language functions.

The receptive language functions are what students do in order to comprehend others’ written and oral arguments. They include identifying, distinguishing, comparing, evaluating, and reflecting on the words and their meaning, and synthesizing them into a concept.

The productive language functions are how students communicate their claims, evidence, and reasoning in support of and against the arguments of others. This includes structuring and ordering written or verbal reasoning for a position; selecting and presenting key evidence and reasoning to support or refute claims; questioning or critiquing arguments of others; suggesting alternative reasoning; refining one’s own thinking; and negotiating differing conclusions.

Here’s an example from the Pebbles, Sand, and Silt Module (grade 2). Students discuss whether soil changes or not. The content objective is for students to deepen their understanding of where soil comes from. They engage in argument by identifying arguments that are supported by evidence and listening actively to arguments to indicate agreement or disagreement. Students are tasked with providing evidence for and against the claim, “Soil does not change.” The cognitive task for students is to analyze whether evidence supports or contradicts a claim. What are the language functions required for this task?

• **Receptive language function.** Students need to understand the concepts of weathering and decay. They need to comprehend the evidence presented by others and determine its relevancy. They must identify the connection (Is there evidence to support the claim?), compare it to their own ideas (Does this connection make sense to me?).
• **Productive language functions.** Students need to communicate their evidence orally and describe why they think it supports or refutes the claim. They might also ask questions, request further explanations, and refine or change their own thinking.

So students must tackle not just the content of weathering and decay, but also the skills of listening and communicating their reasoning. Identifying those skills allows for better differentiation during instruction.

**Crafting a Language Objective.** A science language objective takes into account both science content and language goals. When planning for ELD and science, pay particular attention to the analytical tasks and the corresponding language functions. Consider these questions.

1. What are the science concepts (disciplinary core ideas) students will learn?
2. How will students engage in a practice(s) to deepen their conceptual understanding?
3. How will students process and communicate what they are thinking, given their level of English proficiency?

Here is a language objective based on these questions using the “What is soil?” example.

Students will

• Present evidence for and against a claim,
• Communicate whether they agree or disagree or add on to the ideas of others

**Differentiation.** In this example, to address the varying levels of students’ English proficiency, you, the teacher, might break down the language objective into three levels of expectation—emerging, expanding, and bridging.

1. **Emerging.** State evidence that supports or refutes the claim using sentence frames [e.g., “Soil (changes, does not change) because ____.”] as well as open responses.

2. **Expanding.** State evidence that supports the claim and provides reasoning, using an expanding set of learned phrases (e.g., “I think ____.” “My evidence for ____ is ____.”) as well as open responses.

3. **Bridging.** State evidence that supports the claim and provides reasoning, using a variety of learned phrases (e.g., “I think ____ . My evidence for is ____.”) My evidence against
is ______.”) as well as open responses and provide counter arguments and elaborate on the ideas of others (e.g., “I agree with _____ because ______.” “I disagree with _____ because ______.” “I would like to add that ______.”)

**Strategies Toolkit.** The next phase is to think about scaffolds to make sure all students participate. For this example, the “Put yourself on the line,” strategy is appropriate. Students form a single line (a continuum) with those that agree strongly that soil changes at one end, those who agree strongly that soil does not change at the other end, and those who are open to both ideas or not quite sure, in the middle of the line. Students discuss their reasoning with neighbors and decide where they should position themselves on the continuum.

Here are additional routines and structures that specifically support emergent bilingual students in producing the complex oral language needed for argumentation. (These are modified from Zwiers et al. 2014.)

- Pair students up based on their opposing claims. Student A shares his or her thinking while student B listens. Student B responds by paraphrasing what A said and then asking a question that helps the other think more deeply about their idea. *Why do you think that? What is your evidence?*

- Give students time to get their ducks in a row by first discussing their arguments with one another before the whole-class discussion.

- Provide sentence frames that will encourage active listening and productive talk.
  - *I agree/disagree with _____ because _____.*
  - *I have another idea _____.*
  - *I am wondering what would happen if _____.*
  - *Why do you think _____?*
  - *Would it matter if _____?*

- Have students write/draw their ideas before presenting them. (Speaking before writing also gives students the opportunity to practice using and hearing complex language in preparation for writing.)
Science-Centered Language Development in Grades K–2

Providing Oral Practice
- Pair and small-group discussions
- Science talk
- Oral presentations
- Poems, chants, and songs
- Teacher feedback

Providing Oral Practice

Students acquire English when they have lots of opportunities to hear and practice using the language in meaningful ways. Make sure to allow sufficient time for student discussions and use the protocols and strategies described in the Speaking and Listening Strand section. FOSS investigations are designed for student engagement in collaborative discussions as described in the CCELA CCSS.ELA for all students and are especially critical for students developing their proficiency in English.

Establishing a culture of talk. Establishing and maintaining a culture of talk in the classroom where the voices of all students are respected and valued is key to fostering robust and equitable academic discourse. This means allowing flaws to surface in student’s models, procedures, designs, and explanations as well as limitations in their English-language proficiency. The classroom culture should convey a spirit of shared thinking and discovery in which all students feel encouraged to ask each other questions, push for further explanations, and refute the claims of others. Constructing explanations and engaging in argument from evidence provides emergent bilingual students with the opportunity to hear examples of the type of discourse they are expected to produce (Quinn, Lee, and Valdés, 2012).

Pair and small-group discussions. As a rule, instead of launching questions to the whole group for one student to answer, use think-pair-share, turn and talk, or elbow partner conversations so every student has a chance to share his/her ideas aloud. These strategies not only provide more air time for students to practice English, but also increase the engagement level for everyone. When organizing students for small group work, consider the English proficiency levels of students and mix them up so there is at least one student who is a native speaker or at high level of English proficiency in each group. Use scaffolds such as “put your two cents in” or sentence frames on cards or placemats to support language production.

Science talk. While not all students will participate verbally in whole group science talks at all times, listening to others make claims, provide evidence, and build on the ideas of others provides ELs with examples of how the language sounds and the structures and vocabulary used to communicate ideas in science and engineering.
Oral presentations. Use linguistic supports for students according to their level of proficiency for presenting information orally. For example, allow for thinking time, simple sentences, and flawed language for beginners. Provide models and explicit expectations for the type of language students should use in their presentations.

Poems, chants, and songs. Vocabulary words and phrases can be reinforced using content-rich poems, raps, chants, and songs after students have been introduced to the concepts. As a whole-group activity, create songs, poems, and chants that incorporate what students have learned. When using other resources, make sure the science content is accurate.

Teacher feedback. Rephrase or recast students’ incomplete or flawed statements or questions, So what you’re saying is…? You’re question then is …? The word you’re looking for is ....

Vocabulary development. The Science-Vocabulary Development section in this chapter describes the ways in which science vocabulary is introduced and developed in the context of an active investigation and suggests methods and strategies that can be used to support vocabulary development during instruction in English language arts and ELD. In addition to science vocabulary, students also need to learn the nonspecific-content words that facilitate deeper understanding and communication skills. Words such as compare, identify, direct, produce, receive, source, and reflect are words used in the investigations and FOSS Science Resources and are frequently used in other content areas. Learning these academic vocabulary words gives students a more precise and complex way of practicing and communicating productive thinking. Consider using the strategies described in the Science-Vocabulary Development section to explicitly teach targeted, high-leverage words that can be used in multiple ways and that can help students make connections to other words and concepts. Sentence frames, word wall, concept maps, and cognitive content dictionary are strategies that have been found to be effective with academic-vocabulary development.
### Table 1. FOSS and WIDA/ELPS Integration Chart

<table>
<thead>
<tr>
<th>FOSS Instructional Design</th>
<th>Interactive/Collaborative Modality</th>
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</thead>
<tbody>
<tr>
<td><strong>Setting the Context:</strong></td>
<td></td>
</tr>
<tr>
<td>SEPs: Asking questions and defining problems; Planning investigations</td>
<td>ELPS 2. Participate in oral and written exchanges of information and ideas, and respond to peer or audience comments and questions.</td>
</tr>
<tr>
<td>• Introduce phenomena</td>
<td></td>
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<tr>
<td>• Activate prior knowledge</td>
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<tr>
<td>• Present the focus question</td>
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<tr>
<td>• Challenge</td>
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<tr>
<td>• Make predictions</td>
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</tr>
<tr>
<td><strong>Active Investigation:</strong></td>
<td></td>
</tr>
<tr>
<td>SEPs: Carrying out investigations</td>
<td>ELPS 2. Participate in oral and written exchanges of information and ideas, and respond to peer comments and questions.</td>
</tr>
<tr>
<td>• Collaborative groups</td>
<td></td>
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<tr>
<td>• Following directions</td>
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<tr>
<td>• Making observations and measurements</td>
<td></td>
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<tr>
<td>• Testing and evaluating</td>
<td></td>
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<tr>
<td><strong>Data management:</strong></td>
<td></td>
</tr>
<tr>
<td>SEPs: Analyzing and interpreting data; Using mathematics and computational thinking;</td>
<td>ELPS 2. Participate in oral and written exchanges of information and ideas and responding to peer comments and questions.</td>
</tr>
<tr>
<td>• Record in notebook</td>
<td></td>
</tr>
<tr>
<td>• Organize and process data</td>
<td></td>
</tr>
<tr>
<td>• Make claims based on evidence</td>
<td></td>
</tr>
</tbody>
</table>
Setting the Context:
- **SEPs:** Asking questions and defining problems; Planning investigations
  - Introduce phenomena
  - Activate prior knowledge
  - Present the focus question
  - Challenge
  - Make predictions

Active Investigation:
- **SEPs:** Carrying out investigations
  - Collaborative groups
  - Following directions
  - Making observations and measurements
  - Testing and evaluating

Data management:
- **SEPs:** Analyzing and interpreting data; Using mathematics and computational thinking;
  - Record in notebook
  - Organize and process data
  - Make claims based on evidence

<table>
<thead>
<tr>
<th>Receptive Modality</th>
<th>Productive Modality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELPS 1.</strong> Construct meaning from oral presentations through listening, reading, and viewing.</td>
<td><strong>ELPS 3.</strong> Speak and write about complex informational topics.</td>
</tr>
<tr>
<td><strong>ELPS 2.</strong> Determine the meaning of words and phrases in oral presentations.</td>
<td><strong>ELPS 4.</strong> Construct oral and written claims and support them with reasoning and evidence.</td>
</tr>
<tr>
<td><strong>ELPS 2.</strong> Participate in oral and written exchanges of information and ideas, and respond to peer comments and questions.</td>
<td><strong>ELPS 7.</strong> Adapt language choices to purpose, task, and audience when speaking and writing.</td>
</tr>
<tr>
<td><strong>WIDA.</strong> Process rich descriptive discourse with complex sentences, cohesive and organized, related ideas.</td>
<td><strong>WIDA.</strong> Produce technical and abstract science language, including content-specific collocations, and words and expressions with precise meaning.</td>
</tr>
<tr>
<td><strong>ELPS 2.</strong> Determine the meaning of words and phrases in oral presentations and informational text.</td>
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</tbody>
</table>
### Table 1. FOSS and WIDA/ELPS Integration Chart (continued)

<table>
<thead>
<tr>
<th>FOSS Instructional Design</th>
<th>Interactive/Collaborative Modality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analysis:</strong> SEPs: Analyzing and interpreting data; Developing and using models; Constructing explanations; Engaging in Argument from evidence</td>
<td>ELPS 2. Participate in oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.</td>
</tr>
<tr>
<td>Sense-making discussions</td>
<td>ELPS 5. Conduct research and evaluate and communicate findings to answer questions or solve problems.</td>
</tr>
<tr>
<td>Writing in notebooks</td>
<td>ELPS 6. Analyze and critique the arguments of others orally and in writing</td>
</tr>
<tr>
<td>Vocabulary development</td>
<td></td>
</tr>
<tr>
<td>Answer the focus questions</td>
<td></td>
</tr>
<tr>
<td>Wrap-up/Warm-up review of concepts learned</td>
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</tr>
<tr>
<td><strong>Reading</strong> SEPs: Obtaining, evaluating, and communicating information</td>
<td>ELPS 2. Participate in oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.</td>
</tr>
<tr>
<td>Before, during and after reading strategies</td>
<td>ELPS 5. Conduct research and evaluate and communicate findings to answer questions or solve problems.</td>
</tr>
<tr>
<td>Active Reading</td>
<td>ELPS 6. Analyze and critique the arguments of others orally and in writing</td>
</tr>
<tr>
<td>Making notes</td>
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<tr>
<td>Sense-making Discussions</td>
<td></td>
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<tr>
<td>Answer thinking questions</td>
<td></td>
</tr>
<tr>
<td><strong>Multimedia activities</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Assessment</strong> SEPs: Analyzing and interpreting data; Developing and using models; Constructing explanations; Engaging in Argument from evidence; Obtaining, evaluating, and communicating information</td>
<td>ELPS 2. Participate in oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.</td>
</tr>
<tr>
<td>Writing in notebooks</td>
<td>ELPS 5. Conduct research and evaluate and communicate findings to answer questions or solve problems.</td>
</tr>
<tr>
<td>Response Sheets</td>
<td>ELPS 6. Analyze and critique the arguments of others orally and in writing</td>
</tr>
<tr>
<td>I-Checks/Surveys</td>
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<tr>
<td>Next Step Strategies</td>
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<tr>
<td>Performance Assessments</td>
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<tr>
<td>Interpretive/Receptive Modality</td>
<td>Productive Modality</td>
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<td>--------------------------------</td>
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</tr>
<tr>
<td><strong>ELPS 1.</strong> Construct meaning from oral presentations through listening, reading, and viewing.</td>
<td><strong>ELPS 3.</strong> Speak and write about complex informational topics.</td>
</tr>
<tr>
<td><strong>ELPS 8.</strong> Determine the meaning of words and phrases in oral presentations and informational text.</td>
<td><strong>ELPS 4.</strong> Construct oral and written claims and support them with reasoning and evidence.</td>
</tr>
<tr>
<td><strong>WIDA.</strong> Process technical and abstract science language, words and expressions with shades of meaning.</td>
<td><strong>ELPS 7.</strong> Adapt language choices to purpose, task, and audience when speaking and writing.</td>
</tr>
<tr>
<td><strong>WIDA.</strong> Process a variety of complex grammatical structures and sentence patterns characteristic of science.</td>
<td><strong>WIDA.</strong> Produce multiple, complex sentences and organized, cohesive, and coherent expression of ideas characteristic of science.</td>
</tr>
<tr>
<td><strong>WIDA.</strong> Process technical and abstract science language, words and expressions with shades of meaning.</td>
<td><strong>WIDA.</strong> Process technical and abstract science language, including content-specific collocations, and words and expressions with precise meaning.</td>
</tr>
</tbody>
</table>
## Table 2. Linguistic supports for Grades K–2

<table>
<thead>
<tr>
<th>Levels 1-2. Entering and Emerging</th>
<th>Level 3. Developing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Listening</strong></td>
<td></td>
</tr>
<tr>
<td>• Use visuals, slower speech, verbal cues, and gestures.</td>
<td>• Use levels 1-2 supports when introducing new concepts.</td>
</tr>
<tr>
<td>• Highlight important vocabulary words.</td>
<td>• Repeat/rephrase instructions and information when necessary.</td>
</tr>
<tr>
<td>• Monitor for student understanding.</td>
<td>• Ask students to repeat or paraphrase what they heard.</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td></td>
</tr>
<tr>
<td>• Read FOSS Science Resources aloud in short chunks. Use visual supports such as illustrations, gestures, pantomime, and objects.</td>
<td>• Discuss predictable text structures, reference the active investigation, review new vocabulary words, and use visual and linguistic supports during read-alouds.</td>
</tr>
<tr>
<td>• Use careful enunciation and slower speech.</td>
<td>• Practice reading science word walls and charts.</td>
</tr>
<tr>
<td>• Point out science words on the word wall, charts, and other classroom print.</td>
<td></td>
</tr>
<tr>
<td><strong>Speaking</strong></td>
<td></td>
</tr>
<tr>
<td>• Allow for one-word or short-phrase answers.</td>
<td>• Allow for thinking time, simple sentence responses, and use of present tense.</td>
</tr>
<tr>
<td>• Provide simple sentence frames and word walls.</td>
<td>• Provide sentence frames and interactive word walls.</td>
</tr>
<tr>
<td>• Model pronunciation and use of vocabulary words in context.</td>
<td>• Model and have students practice pronunciation and accurate use of vocabulary words and sentence structures to convey science ideas.</td>
</tr>
<tr>
<td><strong>Writing</strong></td>
<td></td>
</tr>
<tr>
<td>• Allow emergent forms of writing (pictures, letter-like forms, mock words, scribbling).</td>
<td>• Ask students to explain their thinking orally before writing or drawing.</td>
</tr>
<tr>
<td>• Model shared notebook-writing activities.</td>
<td>• Support participation in shared notebook-writing activities.</td>
</tr>
<tr>
<td>• Provide opportunities to use new vocabulary words, phrases, or short sentences that have been introduced in the active investigation.</td>
<td>• Provide opportunities to express ideas in short sentences using new vocabulary words used in class discussions.</td>
</tr>
<tr>
<td>• Explicitly teach English print conventions.</td>
<td>• Allow for use of primary-language words, spelling patterns, word order, and literal translations.</td>
</tr>
</tbody>
</table>
## Science-Centered Language Development in Grades K–2

### Table 2. Linguistic supports for Grades K–2

<table>
<thead>
<tr>
<th>Level 4. Expanding</th>
<th>Level 5. Bridging</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Provide processing time and supports from lower levels when needed.</td>
<td>• Provide processing time when necessary.</td>
</tr>
<tr>
<td>• Encourage students to request clarification, repetition, and rephrasing.</td>
<td>• Use supports from lower levels for complex ideas and new science vocabulary and language structures.</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>• Allow for pauses to restate, repeat, or search for words and phrases to clarify meaning.</td>
<td>• Give support with low-frequency or academically demanding vocabulary when necessary.</td>
</tr>
<tr>
<td>• Provide time for speaking in pairs before whole class discussions.</td>
<td>• Introduce higher-level language functions and structures.</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>• Provide visual and linguistic support when needed to gain or confirm meaning while reading aloud.</td>
<td>• Provide support when needed for comprehension of main points and supporting ideas while reading aloud.</td>
</tr>
<tr>
<td>• Provide support when decoding FOSS Science Resources articles.</td>
<td>• Provide support when needed when decoding and understanding FOSS Science Resources articles.</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>• Ask students to describe and explain their ideas in their notebooks with details.</td>
<td>• Ask students to describe and explain their ideas in their notebooks with a higher level of complexity and detail.</td>
</tr>
<tr>
<td>• Support participation in shared notebook-writing activities.</td>
<td>• Encourage full participation in shared notebook-writing activities.</td>
</tr>
</tbody>
</table>
REFERENCES


References


