When provided with equitable learning opportunities, all students are capable of engaging in science practices and constructing meaning in both science classrooms and informal settings.

Lee, Miller, and Januszyk, 2015

**INTRODUCTION**

**Equity in Science Instruction**

Each classroom dynamic differs from year to year. As the teacher, you assess the needs of your particular students and decide on appropriate methods and supports. In addition to the universal approaches for access and equity embedded in the instructional design described on the next pages, we highlight the following strategies and approaches that you can use to support the specific needs of a particular student(s) in one or more of these populations—ethnically diverse learners, standard English learners, English learners (students whose primary language is other than English who are developing proficiency in academic English), students living in poverty, foster youth, girls and young women, advanced learners and gifted learners, students with disabilities, and students experiencing difficulties with literacy in science and engineering.

Of course, many students fall into more than one of these categories and there is variability within each; however, for purposes of identifying specific needs and appropriate strategies, each group is addressed separately.
When attending to access and equity in your classroom, it’s important to consider these four areas.

- **Student engagement**—what students need to be engaged in science learning.
- **Classroom support strategies**—what the teacher provides in order to ensure access and equity.
- **School support system**—what the school does to make resources available.
- **Home and community connections**—how the school engages families and fosters partnerships with the community.

The FOSS Program plays a critical role within these four areas of support. FOSS provides: 1) engaging experiences through hands-on activities and student collaboration; 2) supports for classroom instruction; 3) technical assistance and suggestions for school and district-wide support; and 4) ways to involve families and the community in the science learning of their children.

This chapter will help you provide equitable learning opportunities for all students by knowing FOSS, knowing your students, and knowing how to plan.

1. **Knowing FOSS.** The first section of this chapter describes how the FOSS Program is designed to address the needs of all students. It answers the questions:

   - What is in the FOSS Program already that allows for maximum access?
   - What are the equity-focused practices that my school, my community, and I can use to ensure a positive bias-free learning environment?
2. **Knowing your students.** The next section helps you understand the needs of your particular students and suggestions for instructional strategies to meet those needs. It answers the questions:

- What are the different populations of students who may have specific learning needs?
- What are specific strategies for addressing the needs of a diverse classroom in science instruction and in general?

3. **Knowing how to plan.** The last section provides a way to think about how to incorporate equitable-focused practices and strategies into your science instruction. It answers the questions:

- Where do I start?
- What should I consider?
- What happens next?

### FOSS for All Students

Every child comes to school with unique experiences, cultural and linguistic backgrounds, and a range of physical and cognitive attributes. This section shows how the FOSS program addresses many of the needs of a diverse student population. The instructional design includes a wide range of learning modalities and provides intrinsic as well as differentiated instruction opportunities. All the investigations are similarly structured to maximize full inclusion based on these fundamental guiding principles:

- All students come to school with language and a wealth of knowledge and experiences that can be tapped into to enrich the learning experience for everyone.
- All students benefit from actively investigating scientific phenomena and engaging in the engineering design process.
- All students are capable of constructing meaning through collaborative social interactions.

The FOSS instructional design incorporates these guiding principles.

**Context.** Establishing the context for the learning experience is beneficial for all students. The *Investigations Guide* provides questions and prompts to help you elicit students’ background knowledge. The Science-Centered Language Development (SCLD) chapter provides additional strategies that are especially useful for English Language Development (ELD). Make it a point to learn about and acknowledge the cultural and linguistic backgrounds of your students and use that

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**NOTE**

Providing equitable learning opportunities requires knowing the curriculum, understanding the diverse needs of the students in your classroom, and responding effectively to those needs.
knowledge to support inclusion and to help students connect new knowledge to their experiences. Every student has something to contribute to help the class as a whole gain a better understanding of the science content.

**Activity.** Exploring phenomena with real materials, objects, systems, and organisms assures engagement for all students. To optimize student interactions, students should be in groups of four facing each other and each child should have a role in conducting the investigation (e.g., getters, recorder, reporter). It is important to make sure all students understand the procedures, are grouped strategically, and are encouraged and assisted in connecting the activity to prior experiences.

**Data management and analysis.** Recording and analyzing data, engaging in oral discourse, and answering the focus questions all require language skills and strategies. The *Investigations Guide* provides questions, prompts, and information-processing structures. The Science-Centered Language Development chapter provides additional literacy strategies and scaffolds to support all students and specifically English learners. Using the same strategies effective in other content areas and in English Language Arts (ELA) for reading comprehension, writing, and oral discourse support sense-making in science for all students. The science notebook is a dynamic medium for differentiation, allowing each student to express his/her own thinking in his/her own way and is a reference tool for students as they analyze their data and construct knowledge from their experience.

**Assessment.** Making thinking visible is critical for differentiation. The embedded assessments and the benchmark assessments show you where students are with their learning, and what next-step strategy they may need to advance or refine their science knowledge and improve their communication skills. Use the formative assessments described for each part—notebook entries, performance assessments, or response sheets. These provide real-time monitoring of student thinking and allow students to use self- and peer-reflection techniques that not only support concept development, but also their metacognitive abilities. The I-Checks are designed to determine the depth of student knowledge. By pushing students to think more deeply, to apply their knowledge, or figure out a new problem, you can determine their level of understanding as well as their developing academic literacy skills. The next-step strategies can then be used to provide ways to differentiate instruction based on students’ needs.
Depth of knowledge. The FOSS investigations lend themselves to differentiated learning by providing a shared experience with phenomena and various access points for sense-making as the concepts are developed throughout the module. These points range in complexity and depth of knowledge (DOK) from levels 1. Recall and Reproduction and 2. Skills and Concepts, to levels 3. Strategic Thinking and 4. Extended Thinking (Webb, 2002). Let’s look at an example from the Motion and Matter Module. In Investigation 1, Part 1, students are learning about magnetic force. They begin by identifying the properties of magnets (DOK level 1); then, they explain the interaction of magnets with other magnets and metal objects—magnetic force (DOK level 2). Next, students are presented with a “floating paper clip” and asked to make a model to explain the forces that keep the paper clip floating in air (DOK level 3). Finally, students are asked to share and critique their models using evidence and reasoning (DOK level 4). In the next investigation, they will apply what they have learned about the magnetic field to a design challenge. Advanced learners use the levels 2 and 3 experiences as a launching pad for more complex questions and explanations, e.g., “So what makes a magnet magnetic? How strong is a magnetic field?” and so forth.

Universal design for learning. The FOSS Program incorporates other strategies directly into the program to address specific learning needs, such as the principles of Universal Design for Learning (UDL). UDL is a framework for guiding educational practice that is flexible in how information is presented, how students respond or demonstrate knowledge, and how students are engaged (CAST, 2011). These strategies benefit a wide range of students and are discussed later in this chapter.
Educators need to implement equity-focused practices and create a positive, bias-free learning environment. These practices include:

- Knowing each student’s learning strengths and needs and planning strategies accordingly.
- Making sure all students engage in the hands-on experiences as described in the FOSS Investigations Guide.
- Allowing sufficient time and support for all students to engage in sense-making discussions as described.
- Integrating a focus on disciplinary literacy and language development in the service of science and engineering learning.
- Providing relevant and rigorous extended science and engineering learning opportunities.
- Integrating English Language Development (ELD), Culturally and Linguistically Responsive Pedagogy (CLRP), and working with special education specialists.

The culture of the classroom is fundamental for all students to learn. The California Science Framework provides a list of critical actions to establish a positive, bias-free learning environment.

- Recognize and address biases and inequities and support students to do the same.
- Create and sustain “growth mindset” learning environments that support students’ positive attitudes toward, persistence in, and self-efficacy in science and engineering courses.
- Integrate culturally and linguistically responsive pedagogy and promote an “additive stance” toward diversity.
- Initiate respectful and positive teacher-to-student interactions with students and inspire students to see themselves as scientists and engineers.
- Initiate respectful interactions with students’ parents and guardians and encourage families to support their children as successful scientists and engineers.

The first goal of FOSS is scientific literacy for all students. It is the first goal because we believe that all students deserve access to science in order to build a deeper understanding and appreciation for the world around them. This goal cannot be reached by instructional materials alone. It requires teachers, schools, and community to not only connect with students, but to take deliberate action to promote equity and access with science.
PLANNING FOR INSTRUCTION

Planning instruction to meet the needs of all students within the context of science can be overwhelming as a teacher. How you go about planning relates very closely with your understanding of the curriculum and your students. If you are new to FOSS, begin by focusing on the basics. The instructional design of FOSS incorporates many of the strategies for inclusion for all students. As you become comfortable with the structure and flow of the active investigations, start choosing other components to focus on more deeply, such as building a positive classroom culture, notebooks, sense-making discussions, and assessment. Be reflective. Constantly ask yourself, What is working well for all my students? How do I know they are learning? Who needs more support or more challenges? Are there patterns I’m observing? The progression for access and equity in your science instruction might look something like this:

• **First time.** Teach the FOSS investigations as written in the *Investigations Guide*. Build a positive classroom culture that fosters responsive teaching. Pay attention to EL notes and provide “just-in-time” scaffolding as needed. As students develop their abilities to engage in the practices, gradually withdraw the scaffolding. The goal is for all students to gain independence in achieving the tasks at hand. Provide composition books for students to use as science notebooks. Start with students gluing or taping in the printed student notebook sheets. As you and students become more comfortable with the use of notebooks, transition to having students write directly in their notebooks and organizing their data independently. Give students the response sheets as described to monitor for understanding.

• **Second time.** Now that you have some experience with teaching the FOSS module, reflect on what worked well with the previous instruction and areas where you want to improve. Reflect on student learning. Which scaffolds are effective? How can you help students transition more quickly to independence? Use the embedded assessment opportunities to look for trends. Try a next-step strategy. Focus on a few areas of growth to meet specific students’ needs. Use the strategies provided in this chapter to address access and equity. Keep track of where students need additional supports or challenges and look for opportunities to provide more “just-in-time” scaffolding during the investigations such as:

**NOTE**

Basic principles of culturally and linguistically responsive teaching are

- Promote and model a positive disposition toward diversity.
- Recognize and leverage cultural and experiential backgrounds.
- Value language diversity and address language status.
- Cultivate the development of academic language.

From the *California Science Framework*. For more information, see Reference Section.
Prompting students to elaborate on their responses in order to clarify their thinking, extend their language use, or make connections to their life outside of school. Can you say more about ______? What is another way to describe ______?

Paraphrasing students’ responses using academic vocabulary. So what I hear you saying is ______? Adjusting instruction on the spot based on how well students are able to engage in the sense-making tasks. Let’s pause and think about the evidence we have so far ______. What else do we need to consider in order to understand ______? Let’s take another look at the data. What else might account for why ______?

Connecting to students’ prior knowledge or to the next part of the investigation. What does ______ remind you of? When have you observed ______ before? What happened when we ______? What do you think will happen when ______? Think about how this might affect ______.

• Third time. As you develop your expertise, routinely reflect on student learning using data from the embedded assessments and the benchmark I-Checks. Work with grade-level colleagues to refine your practices with your most vulnerable students. Looking at student work together can be very illuminating and an effective way for all teachers to improve their practice. Make access and equity a priority. Here are some questions (adapted from the California Science Framework) to think about as you plan for differentiated learning for each investigation.

First, review the Overview section of the Investigations Guide to make sure you know:

• The anchor phenomenon and driving question for the module; the guiding question for each investigation phenomenon, and how the focus questions for each part build a conceptual framework for students so they can answer it.

• The focus question for the investigation and what students will do in order to answer it.

• The NGSS and Common Core ELA standards this investigation addresses.

Now, think about your students:

• What background knowledge, skills, and experiences do my students have related to this investigation?
Planning for Instruction

• How complex are the texts and tasks I’ll use? What are the language demands in these tasks and texts?
• How will students make meaning with the science content, express themselves effectively about it, and develop language through the investigation?
• What types of scaffolding, accommodations, or modifications will individual students need to effectively engage in the lesson tasks?
• How will my students and I monitor learning during and after the lesson, and how will that inform instruction?
• Are there opportunities to make home or community connections? Role models?

Refer to the strategies listed by demographic in the following section for ways to differentiate your instruction based on how you answer these questions. Use scaffolds that have the widest ranging impact:

- Tap into what students already know about the investigation topic.
- Model and thoroughly explain the procedures for the investigation.
- Continually monitor for understanding.
- Adjust the sense-making discussions to incorporate strategies to meet the needs of your students.
- Use the collaborative group structure including norms and protocols for inclusion.
- Use the guiding questions in the *Investigations Guide* and strategies found in the Science and Engineering Practices and Crosscutting Concepts chapters.
- Include the range of visuals that are provided or suggested (graphic organizers, diagrams, images, videos, and multimedia on FOSSweb).
- Provide students with language models such as sentence frames, word walls, writing frames, and examples of student notebook entries.

Model these strategies and ways to engage in the practices for students and be explicit about their purposes. Add new strategies and monitor their effectiveness. Most of all, keep high expectations for all students. If you believe all students can learn disciplinary cores ideas, engage with science and engineering practices, and utilize crosscutting concepts, they will rise to the occasion.

*Access and Equity in Grades K–8*

فترنوت

جاء في ملاحظة: تأكد من قراءة روند محادثات التفكير الم каталوجي للتعليم ثلاثي الأبعاد في فصلك الدراسي للحصول على المزيد من المعلومات. 

© 2019 ملكية لجامعة كاليفورنيا، بيركلي، بموجب قرارات استخدام أخرى أو إعادة نشر من دون إذن أدق.
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(Adapted from Lee, Miller, and Januszyk, 2015)
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For non-mainstream students, equitable learning opportunities occur when school science: (a) values and respects the experiences that all students bring from their homes and communities, (b) articulates this cultural and linguistic knowledge with disciplinary knowledge, and (c) offers sufficient educational resources to support science learning.

Lee and Buxton, 2010

The table on the previous two pages identifies strategies for working with diverse learners. The strategies that are effective for more than one group of students are explained only once, but are referenced in the table where applicable. Student engagement and support for classroom instruction are closely related and therefore combined in one column.

Ethnically Diverse Learners

We begin with a discussion of this demographic as it overlaps with many of the others. The following approaches are adapted from Educating Everybody’s Children: Diverse Teaching Strategies for Diverse Learners, Revised and Expanded 2nd Edition, Edited by Robert W. Cole. We describe how these approaches can be used before, during, and after FOSS instruction, and with other related learning experiences.

Strategies for student engagement and classroom support

- **High expectations.** The investigations are designed with access points for all students with the expectation that all ethnically, culturally, and linguistically diverse students can be successful. Ways to scaffold the instruction are indicated in the margins of the Investigations Guide (see teaching notes and EL notes). Use the following strategies as well as other approaches for helping students manage challenging language demands or to support their developing abilities, when appropriate, but do not decrease the rigor of the lessons. Model and encourage a “growth mindset” that values effort and resilience.

For example, in the FOSS Motion and Matter Module, students are expected to make a cart based on certain criterion and constraints. During their first attempt, the teaching note in the Investigations Guide (Investigation 3, Part 1, Step 4) advises, “Engineering is an iterative enterprise. It requires perseverance and new ways of thinking. Problems when working on prototypes are expected. Help students see that problems are a natural part of the engineering process and should not be regarded as failure.” The expectation is that students will confer with each other, troubleshoot problems, and redesign their carts.
• **Empathy for students.** Taking time to know the individual needs and strengths of your students and looking for opportunities and connections with the science learning that allow them to share their concerns, hopes, and dreams goes a long way to show you are invested in students. In science, there are opportunities in the FOSS investigations for teachers and students to care for the environment by caring for plants and animals both inside and outside the classroom, recycling, and solving problems relevant to students. Look for suggestions in the extensions section for ways for students to participate in caring for their community and other citizen science projects.

• **Students’ funds of knowledge.** Tap into students’ backgrounds. Student motivation increases when they are asked to share their experiences and their ideas are valued. Make sure to elicit students’ prior knowledge before each investigation as described in the *Investigations Guide* and throughout the investigation as appropriate. As new science content is introduced, make connections to their understanding in the classroom to their backgrounds and experiences. Ask yourself, “How might the concepts developed in this investigation connect to their lives? Are there culturally relevant articles, books, websites, videos, images, etc. that connect to the ideas in this investigation that we can add to our explorations and discussions?”

• **Identify and dispel stereotypes.** FOSS is careful to use terms such as “human,” not “man” and to intersperse between the pronouns “he” and “she.” When referring to animals under investigation, try to use “it” if the gender is unknown instead of automatically assuming it’s a “he.” Discuss stereotypes of scientists as older white males in lab coats and why the belief is common. Promote student agency and positive attitudes about science by referring to the contributions of science from scientists that represent the ethnic backgrounds of your students. For example, in the *Earth History Course*, during the geoscenarios project, students have the opportunity to learn about 16 different specialists, representing a wide range of ethnicities and gender identities, who contribute to geological research or engineering.

• **Culturally-compatible learning environments.** Structures and protocols are described in the *Investigations Guide* to support the management of materials and to promote collaborative and active learning. If these are new types of interactions for students, take time to review norms and expectations, and to discover any potential conflicts with students’ cultural and linguistic
experiences. Look for appropriate ways to incorporate social interactions that are culturally compatible with your students’ customary ways of communicating, e.g., call and response, think-pair-share, art connections, etc.

- **Cooperative learning strategies.** Mix up the small groups for FOSS instruction so students of different backgrounds and ethnicities can get to know each other better as they conduct investigations and engage in collaborative discussions. Use the suggested methods for establishing roles and responsibilities that promote cooperative learning (refer to the Overview chapter in any module or course for more information about these roles). One person in the group is the getter of the materials; another is the starter for each task; the recorder writes down the group’s ideas; and the reporter shares out the group’s responses in the whole class discussions, and these roles rotate. Focus students’ attention on both the task and the process. “How well did you work together as a group? Did everyone feel included and respected? What could you do better next time?”

- **Connect to cultures, languages, and experiences.** Incorporate your students’ home culture expected patterns of social interaction and discourse as much as possible. For example, students who care for younger siblings or are cared for by their older siblings may feel more comfortable working in collaborative groups during science and engaging in small-group discussions. Particularly in elementary school, students who have responsibilities at home in caring for the home, might also feel comfortable given the role of helping to manage the FOSS materials and to care for the classroom critters and plants.

- **Multiple forms of FOSS assessment.** The FOSS assessment system provides many ways to assess student progress. Make it a habit to do a quick review of a sample of student notebook entries every day and observe students as they engage in the science and engineering practices. Use the response sheets and I-Checks as indicated in the *Investigations Guide* to gauge student understanding. Allow time for students to review the I-Checks and revise their thinking. Remember, I-Check stands for “I check for my own understanding.” (See the Assessment chapter in the *Investigations Guide* for more information.)
School support systems

- **Culturally relevant curriculum.** Incorporate culturally relevant curriculum and instructional materials that recognize, incorporate, and reflect students’ heritage and the contributions of various ethnic groups. FOSS Science Resources include biographies and references to a diverse range of scientists and engineers. In addition, you can use the Science and Engineering Careers Database on FOSSweb. Encourage discussions and further research into the work of scientists and engineers that represent the demographics of your students.

- **Integrate the arts.** There are opportunities in every FOSS module and course for students to enhance their science learning through experiences with the arts. The art extensions provide opportunities to spark students’ creativity and expression of ideas related to science and engineering. Students record their observations through drawings in their notebook; they make diagrams and illustrations to use as models to explain their thinking, and they can incorporate their own cultural connections to the science learning through both traditional and contemporary forms of art, dance, music, and drama. For example, constructing a mobile during art class demonstrates an understanding of a stable system.

- **Promote student health.** Learning about how the human body works helps students understand the importance of a healthy lifestyle. Look for opportunities in the investigation and reading discussions to talk about ways they can stay healthy. For example, in the Populations and Ecosystems Course, students learn about the health benefits of drinking water instead of other sugary or caffeinated beverages. You can also connect the science learning to other health initiatives at your school or in your community.

- **Role models.** Bring role models from the community to the classroom to speak about their education and careers. Interacting with undergraduate science majors and graduate students can be very motivating for all students.

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**NOTE**

For more on culturally responsive teaching, see Geneva Gay and Gloria Ladson-Billings’ work in the Reference section of this chapter.
Home and community connections

- **Know students’ cultures.** Understanding socio-cultural norms of your students’ families helps you better comprehend their behavior in and out of the classroom. The home/school connections (K–5 modules) and some homework opportunities (grades 6–8 courses) provide opportunities for students to gather information from their families that relate to the FOSS investigations. For example, in the Structures of Life Module, students are asked to find seeds at home and discuss what types of seeds they use in cooking. In the Waves Course, students are asked to bring in instruments from home to consider their various sounds.

- **Active participation of families.** Talk with families about your expectations for their child’s science learning as well as theirs. Invite family members into the classroom to share their knowledge and experiences with the science and engineering concepts explored in class. Have students routinely share what they are learning in science with their families. You can also share community resources with families such as museums and parks to visit for a science experience together.

- **Community ties and community schools.** FOSS can extend outside the classroom through afterschool instruction (there are always more things to explore and investigate either through student-generated questions, going deeper into the investigations, the extension activities, or other resources on FOSSweb), family science nights, science fairs, and other community events. FOSS can also extend to and support project or place-based learning, providing the foundational science content to help solve a problem in the community.
Standard English Learners

Standard English Learners (SELS) are native speakers of English who are ethnic minority students (e.g., African-American, Native Americans, Southeast Asian-American, Mexican-American, Native Pacific Islander) whose mastery of “standard or academic English” (the language of school) is developing. These students usually speak a nonstandard English language at home. The goal for academic language development is for students to be multilingual in their home language, the language of school, and the language of science. The following strategies have been used effectively in Los Angeles, California and in other school districts to support SELs (Cobbs, 2012; LAUSD, 2012). Here is how you can apply these approaches to FOSS instruction and/or to interdisciplinary connections in ELA, social studies, or art.

Strategies for student engagement and classroom support

Strategies for ethnically diverse learners are also applicable for standard English learners.

- **Contrastive analysis.** Use science discussions and writing as the context for the systematic study of your students’ home language and how it compares to the academic science language used in school. Students can discuss the structural differences and similarities in the way English is used depending on audience, topic, content, mode of communication, and purpose. Explicitly teach the different ways of communicating when in collaborative groups vs. whole-class discussions.

- **Instructional conversations.** Strategically group students so they have opportunities to engage in science discussions with others at high levels of understanding. Use the questions and prompts in the *Investigations Guide* that promote analysis, reflection, and critical thinking. The Sense-Making Discussions for Three-Dimensional Learning chapter has samples of these different types of questions. See the Science-Centered Language Development chapter for a description of participation protocols students can use to structure the small-group discussions.

- **Academic language development.** Model and encourage use of science vocabulary, sentence structures, and norms for academic discourse, while also valuing students’ home language. For example, a student might say, “The water carries the sand away.” The teacher would respond, “That is a very good description of what you observed; scientists call that erosion.” Help students to understand the type of “registers” of language to use in talk and text in particular contexts, such as notebook entries versus formal reports, or small group discussions versus presentations.

**NOTE**
See the Science-Centered Language Development chapter for more on academic language development.
• **Advanced graphic organizers.** Use the visual tools and representations of information suggested in the *Investigations Guide* to help students understand the structure of concepts and the relationships between ideas to support critical thinking processes. Explicitly teach how and why tools such as a Venn diagram are used with the expectation that students will eventually be able to choose which graphic organizer is appropriate for thinking about a concept on their own.

**School support systems**

Strategies for ethnically diverse learners are also applicable for standard English learners.

• **Validation of home language.** The language students use when engaged in sense-making discussions should be valued for the ideas expressed and not “corrected.” Explore the origins and conventions of students’ home language and how they compare and contrast to the academic language of school.

**Home and community connections**

Strategies for ethnically diverse learners are also applicable for standard English learners.

• **While students may speak English at home, the language of science might be new for both students and families. Keep in mind that language is tied to culture. Students should feel comfortable expressing their ideas in both their home language and the language of school; both are valid means of communicating.**
English Learners
Engaging in the science and engineering practices requires intensive and complex language and cognitive tasks that can be challenging for English learners. Students read analytically, engage in academic discussions, write extensively, and interpret visual representations of scientific phenomena. To support language development within science instruction, students must engage in “meaningful interactions with intellectually challenging content and tasks that motivate learning, stimulate their thinking and curiosity, and extend understandings” (California Science Framework, 2016).

The FOSS investigations are designed to do just that. To support English learners in these endeavors, “just-in-time” scaffolds can be found in the strategically placed EL notes within the margins of the Investigations Guide for each investigation part. These notes suggest when to provide visuals or gestures, monitor for comprehension, and explicitly address the language demands of the lesson. In addition to the strategies described in this chapter that apply to English learners, (academic language development, cultural and linguistic capital, and disciplinary literacy) see the English Language Development section of the Science-Centered Language Development chapter for an extensive array of approaches and best practices for integrating ELD and science, including crafting language objectives, vocabulary development strategies, and ways to align with English Language Proficiency Standards for WIDA, ELPS, and state-specific standards.

Strategies for student engagement and classroom support
The Science-Centered Language Development chapter describes the strategies listed in the chart below that have proven to be effective in activating students’ prior knowledge, ensuring access to the science learning experience (comprehensible input), developing academic language, and supporting productive oral discourse.

<table>
<thead>
<tr>
<th>English Language Development Strategies Used with FOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activating prior knowledge</td>
</tr>
<tr>
<td>• Inquiry chart</td>
</tr>
<tr>
<td>• Circle map</td>
</tr>
<tr>
<td>• Observation posters</td>
</tr>
<tr>
<td>• Quick write</td>
</tr>
<tr>
<td>• Kit inventory</td>
</tr>
<tr>
<td>Using comprehensible input</td>
</tr>
<tr>
<td>• Multiple exposures</td>
</tr>
<tr>
<td>• Pictorials</td>
</tr>
<tr>
<td>• Word/picture cards</td>
</tr>
<tr>
<td>• Supported reading</td>
</tr>
<tr>
<td>• Graphic organizers</td>
</tr>
<tr>
<td>Developing academic knowledge</td>
</tr>
<tr>
<td>• Language learning objectives</td>
</tr>
<tr>
<td>• Sentence frames</td>
</tr>
<tr>
<td>• Words walls</td>
</tr>
<tr>
<td>• Concept maps</td>
</tr>
<tr>
<td>• Cognitive content dictionary</td>
</tr>
<tr>
<td>• Word analysis</td>
</tr>
<tr>
<td>Oral discourse practice</td>
</tr>
<tr>
<td>• Think-pair-share</td>
</tr>
<tr>
<td>• Participation protocols</td>
</tr>
<tr>
<td>• A/B partner prompts</td>
</tr>
<tr>
<td>• Teacher and peer feedback</td>
</tr>
<tr>
<td>• Songs, chants, raps, poems</td>
</tr>
</tbody>
</table>

Access and Equity in Grades K–8
School support systems

Strategies for ethnically diverse learners are also applicable for English learners.

- **Designated English language development.** Many schools have a designated time to work with English language development. During this time, students can develop English through the context of science. Strategies, such as doing a kit inventory, can be found in the Science-Centered Language Development chapter.

- **Integrated English language development with science.** During designated science time, classroom teachers can incorporate strategies found in the Science-Centered Language Development chapter. Staff members working with English learners are encouraged to support students during science time to help students develop English in the context of science.

Home and community connections

Strategies for ethnically diverse learners are also applicable for English learners.

- **Communication with family in home language.** Keep families informed of what’s happening in science by using the translation tools you have available at your site. See FOSSweb for Spanish translations of the letter home to family (for K-5), the home/school connections, and the student notebook sheets and assessments. The FOSS Science Resources book is also available in Spanish.
**Students Living in Poverty**

In addition to getting to know your students and looking for ways to connect with them, there are areas of concern that can be addressed with FOSS to help low-income students who are struggling in school. These strategies are adapted from Jensen 2013.

**Strategies for student engagement and classroom support**

- **Empathy for students.** See description in the Ethnically Diverse Learners section.

- **Vocabulary development.** Students living in poverty are more likely to have limited experience with academic language. With FOSS, all students are learning the language of science. Model the use of science-specific and general academic vocabulary and structures throughout the lessons. Encourage students to use the vocabulary and provide opportunities for them to practice orally and in writing. See the vocabulary development section of the Science-Centered Language Development chapter for an extensive list of strategies for reviewing and reinforcing science vocabulary.

- **Recognize effort.** Students living in poverty may appear unmotivated due to lack of hope or optimism, depression, or learned helplessness. The FOSS activities provide hooks for student engagement by appealing to their curiosity. Look for teachable moments that connect the science and engineering ideas to students’ lives. Set high expectations and provide constructive feedback. When affirmed, challenged, and encouraged, students put forth more effort.

- **Growth mindset and resiliency.** Help students overcome low expectations and a vision of a negative future. Instruction and assessment should be viewed as an opportunity for them to continue a path of learning that never ends. Explicitly teach students about having a growth mindset—if I know where my strengths and weaknesses are and I continue to be thoughtful and work hard, I can make progress. The growth mindset models what scientists do. Scientists use the information they have to argue for the best explanation, but they keep an open mind, so that when new evidence emerges, they can incorporate that into their thinking, too.

- **Support cognitive processing skills.** Students living in poverty may demonstrate lower academic achievement, lower attention spans, and other cognitive difficulties resulting in problem behavior or giving up. FOSS investigations are rich, engaging, and intellectually stimulating. The investigations can be
broken up into smaller components by stopping at the breakpoints indicated in the guiding steps. Take the time to help students work on the core academic skills and cognitive behavior, such as self-monitoring, they need to be successful in school. The science notebook is the perfect tool for students to learn how to organize, study, take notes, prioritize, and remember key ideas. They can then use these skills to engage in the higher-level cognitive tasks involved in making models, constructing explanations, and engaging in argument from evidence.

**School support systems**

- **Health and nutrition.** Students living in poverty are more likely to experience poor nutrition and unhealthy habits, which can affect behavior and concentration. Be sure to do the outdoor parts of every investigation. See the Taking FOSS Outdoors chapter for more information. These activities provide physical activity, and are not only engaging and informative, but also stimulate the flow of oxygen and give students the energized feeling they need to focus on academics.

- **Social Emotional Learning.** Students living in poverty may face disruptive or stressful home relationships and acute distress. This can result in inappropriate behavior at school. Social Emotional Learning (SEL) is crucial for students to overcome these barriers. Working in collaborative groups depends on students practicing the competencies of SEL: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. Make working on these competencies part of the learning objective for every science lesson. Incorporate specific SEL strategies to meet the needs of students. For example, students coping with anger management benefit from a quiet place for them to take a time out from interacting with others when necessary. Students should also feel free to write about how they are feeling about their science experience and issues that affect their learning as well as their emotional well-being in their science notebooks. Be aware of behaviors or issues that might come up in the sense-making discussions or readings that may be triggers for students.

**Home and community connections**

- **Foster partnerships.** Make connections with philanthropy organizations or local business to provide essential school supplies or necessary science materials. Look for opportunities for students to participate in projects and programs geared towards supporting pathways for STEM, higher education, and careers.
Foster Youth

Consistent, motivating, and relevant science instruction can be an important part of providing stability for children in foster care. FOSS instruction supports strategies that promote resiliency—caring and supportive relationships, positive and high expectations, and opportunities for meaningful participation in the classroom. (McKellar, 2011)

**Strategies for student engagement and classroom support**

- **Empathy for students.** See description in the Ethnically Diverse Learners section.

- **Provide structure.** Orient new students to the rules of engagement for FOSS investigations. Explain the norms and roles for working in collaborative groups and participating in sense-making discussions, how materials are organized and distributed, how to care for live organisms, and expectations for writing in science notebooks. Maintain a structured and predictable routine for science time. Post and review the safety rules (for indoors and outdoors) and be clear about limits and consequences when students are interacting with materials and live organisms and when they are engaging in the outdoor activities. Pair a new student with a buddy who knows the ropes and when assigning him/her to a group, consider students who are particularly helpful and understanding.

- **Bridge science experience.** Assess where students are in their previous science learning and use resources such as the tutorials, online activities, virtual investigations, streaming video, and interactive eBooks to help get them up to speed with the rest of the class. Continue to monitor and communicate their progress through daily-embedded assessments (notebooks entries, response sheets, and performance assessments). Set expectations high and provide scaffolds for student success such as breaking up the investigation into fewer steps at a time. Continually praise students for their efforts and accomplishments.

- **Reinforce strong social skills.** Use the collaborative group structure and norms for productive discussions. Provide positive feedback when you observe students actively participating and respectfully exchanging ideas. See the Social Emotional Learning strategies in the previous section for more information.
• **Provide individual attention.** Listen and value what students have to say and try to find time for one-on-one conversations. Uncover interests a student might have that will lead to further inquiry in science and engineering and pair that student up with others who have the same interest.

**School support systems**

• **Mentors.** Foster youth might be connected with various programs such as Big Brother/Big Sister. Carrying that idea into the school setting might include a kindergarten teacher connecting with a third grader and having them help during science time, or a teacher-helper guiding a student in conducting a science fair project. In middle school, you can pair a new student with a student who is thriving in your science class, asking the experienced student to help the new student set up their science notebook, and to show the new student classroom routines and safety protocols.

**Home and community connections**

• **Support for caregivers.** Send foster parents the FOSS Letter to Family (for K–5 modules) and any communications about the classroom science learning to let them know what’s been happening in the classroom. Encourage parent involvement while at the same time recognizing their time may be limited.

• **Community building.** Encourage student involvement in the class by giving them responsibilities such as caring for critters or helping to set up and clean up materials. Look for opportunities in the science learning experience where they can make decisions and have choices. Occasionally, multiple foster youths live in the same house. Provide ideas for science experiences in which all can engage together. For example, if students are working in life science, an outdoor insect hunt provides an opportunity for a shared learning experience. Bolster sibling support by checking in with families and the teachers of your student’s siblings to look for ways to connect their science learning to their combined interests and strengths.
Girls and Young Women

The following section addresses gender disparities in science achievement that have been attributed to an early “experience gap” between boys and girls. It is important to recognize that the big picture goal is to provide a learning environment that is “gender neutral.” In other words, there shouldn’t be activities or specific interests tailored “for girls” and “for boys.” Boys and girls should both feel fine pursuing interests that have historically been associated with one gender or the other, i.e., boys like making cars and rockets; girls like studying animals and helping people.

Nevertheless, as we work to overcome the barriers of stereotypes in science, there are approaches for immediately countering trends of inequity that may be apparent at your school site. For example, research shows that making sure girls have meaningful and relevant science experiences early on helps them to see the connection between school science and science as a career. To lessen the gender gap, instructional strategies are needed that enhance achievement, self-efficacy, and participation of girls in science. Here is what the research (Baker, 2013) says about what girls need:

1. Early science instruction beginning in prekindergarten.
2. Relevant curriculum that addresses girls' interests and provides many opportunities for genuine inquiry and tinkering experiences.
3. Greater emphasis on physical science and the use of computers.
4. Integration of reading and writing in science.
5. Careful attention to how groups are formed.
6. Activities that build self-efficacy.
7. Appropriate role models.
8. Voiced and unvoiced messages that science is for everyone.
9. Student-centered teaching.

**Strategies for student engagement and classroom support**

- **Relevancy.** Help students to see how the phenomena they are studying relate to the storyline or theme that runs through the FOSS module. Focus on the concepts that address real-world experiences that may be of special interest to the girls in your classroom. Be sure to spend time on the engineering design process opportunities in each module and, when necessary, encourage girls to take risks and try out their ideas.
• **Literacy and art connections.** Allow extended time for writing and drawing in student notebooks. Look at the art and ELA extensions at the end of each investigation for activities that may be of interest to some students in your classroom to do as homework. Emphasize and provide nonfiction science reading in addition to *FOSS Science Resources*. Encourage the use of metacognitive self-management and applying reading comprehension strategies when reading science texts.

• **Attention to materials, time, and groupings.** Make sure there are enough materials available to prevent quieter students from being passive observers and others from dominating the hands-on part of the investigation. Allow enough time to complete hands-on inquiry activities, including time for asking questions, revising, and discussing. Experiment with grouping. All-girl groups are sometimes more effective for engaging and motivating girls.

• **Support self-efficacy.** Help girls see how much they are learning. Routinely use the peer and self-assessment strategies described in the assessment chapter so students can monitor their own learning and be aware of their achievement. Be sure to send positive messages to girls about their competence in science, praising their efforts, creativity, and resilience—not innate abilities. Discuss gender issues related to science.

• **Motivation.** Be sure to emphasize the affective components of the investigations and relevant topics that address concerns about protecting the environment and helping animals and people. When designing carts in the *Motion and Matter Module*, you might frame the challenge as “Make an ambulance that can get people to the hospital in a hurry.” You may find that some students gravitate more to the aesthetics of science, technology, and engineering. Allow students to make their carts aesthetically pleasing. You might discuss how engineers balance the criteria of function and aesthetics when designing things like cars, computers, and other devices.

• **Confronting stereotypes.** Read aloud books that explore non-stereotypical male and female roles and provide opportunities for role playing and visits from role models.

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**NOTE**

Research shows that when nonfiction literature is integrated with inquiry, kindergarten girls understand science better and perceive themselves as competent learners (Patrick, et al.). See FOSStweb for a list of suggested books.
School support systems

- **Develop science identity.** Help girls to develop their own science identity. Encourage them to think, work, and talk like scientists. Provide resources and discuss areas of science that might peak girls’ interest in science careers. Be sure the message is that science is for everyone. Use gender-neutral terms and examples of women in science. Posters about science should represent both male and female scientists. Be cognizant of how much attention is paid to boys during science time, especially during discussions.

- **Role models.** Bring role models to the classroom to speak about their education and careers. Interacting with undergraduate science majors and graduate students can be very motivating for students.

- **Selecting literature.** When choosing children’s literature, be careful to examine the materials carefully for science content errors and misconceptions, fantasy, gender stereotyping, and anthropomorphisms.

Home and community connections

- **Sharing resources.** Provide families with information about after school programs or camps, especially those with a focus on women in science.

- **Partnering with organizations.** Identify local organizations that are active in science/engineering-related issues, such as Girl Scouts doing a recycling program or Women Who Code. Reach out to organizations that help encourage an interest in science.

**NOTE**
The Science and Engineering Careers Database on FOSSweb provides many examples of women in science. Have students engage with the database.
Advanced Learners and Gifted Learners

FOSS provides academic rigor for all students and provides the opportunities for differentiation for advanced and gifted students who have unique needs. For these students, science instructional strategies should include fast pacing, different levels of challenges, opportunities for self-direction, and strategic grouping (Lee, Miller, and Januszyk, 2015). Students should also have opportunities to be creative and innovative. In this section we describe 1) ways to differentiate in the regular classroom and 2) how to use FOSS in a designated GATE classroom.

Strategies for student engagement and classroom support

• **Fast pacing.** For students who are quick to grasp the concepts of the investigation, use the sidebar suggestions and extension ideas for opportunities to extend and deepen their learning. For example, in the Energy Module, fourth grade students are challenged to come up with a way to determine speed using their ball and ramp system. The teaching note in the sidebar advises the teacher that there are many different solutions and to encourage students to work through the engineering process. Extension menus are also effective tools for advanced students to work independently at an accelerated pace. (See example on the following page.)

• **Different levels of challenges.** FOSS investigations provide a foundation for students to engage in the science and engineering practices in order to extend their learning of the disciplinary core ideas in greater depth and to apply complex reasoning in their explanations, solutions to problems, and written and oral arguments. Encourage students to continually expand on their thinking through the creation of more complex models, explanations, and arguments from evidence. In *A Teacher’s Guide to Using the NGSS with Gifted and Advanced Learners*, Adams, Cotabish, and Daily propose a ninth practice: Solving problems in novel ways and posing new scientific questions of interest to investigate. Be sure to pace your FOSS instructional time to allow for students to engage in this practice when the opportunities arise.

The NGSS encompass another important dimension, crosscutting concepts, for tapping into students’ higher-level thinking capacities. FOSS uses the crosscutting concepts as intellectual tools to help students conceptualize disciplinary core ideas and to view their science learning as a process of integrating and looking for the relationship of concepts. In the *Investigations Guide*, the crosscutting concepts are called out in the margins,
may be explicitly pointed out and discussed in the sense-making discussions, or may form part of a wrap-up/warm-up sharing of ideas. Another resource for using the crosscutting concepts are the crosscut symbols and questions developed by Peter A’Hearn (http://crosscutsymbols.weebly.com). The symbols can be used to direct students thinking to another lens. For example, fourth grade students are exploring ecosystem in the **Environments Module**. The focus question is what are the roles of organisms in a food chain? To challenge a student to think differently about what the food chain model explains, you might pose questions about energy and matter, such as what does energy do in a food chain system? how does it change? what is the role of matter? and how does it change in the food chain system?

See the section below on using crosscutting concepts in the Gifted and Talented Education (GATE) classroom for more ways to accelerate student learning in FOSS using the universal themes.

**• Opportunities for self-direction.** At points in the investigation where students are effectively developing their understanding of the content, step back and present the activity in a more open-ended fashion. For example, instead of providing the focus questions, have students formulate their own questions, and plan the investigation within the constraints of the classroom, the available material, and in line with the learning goals you’ve established.

In cases where the rest of the class needs to review or proceed at a slower pace, plan for complex extension activities. Refer to the extensions at the end of the investigation for suggestions you can use to provide advanced students with a menu of choices to meet their learning goals.

Here is an example of an extension menu for weather from the **Earth and Sun Module** for grade 5 and the **Weather and Water Course** for middle school.

<table>
<thead>
<tr>
<th><strong>Weather Extensions Menu</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explore</strong> different types of digital weather station tools. Find out from the manufacturer how they are used to collect weather data.</td>
</tr>
<tr>
<td><strong>Research</strong> how one become a meteorologist. What types of science and math classes does one need to take? How has the occupation changed?</td>
</tr>
<tr>
<td><strong>Create</strong> Earth atmospheric posters. Use graph paper to set up a scale to include all the layers from the troposphere to the exosphere (0–600 km altitude).</td>
</tr>
</tbody>
</table>
• **Strategic grouping.** Periodically mixing up groups is a good idea for the social health of the classroom community; however, keep in mind that the needs of advanced students are better served when they are paired up or placed together in small groups. Consider the cognitive demands of the task and adjust groupings accordingly.

**School support systems**

Aspects of some of the universal and commonly used strategies for Gifted and Talented Education instruction are embedded in the FOSS investigations. For example, in Sandra Kaplan’s work the Think Like a Disciplinarian strategy, can be used effectively to increase the level of depth and complexity of any of the FOSS lessons. Other methods include using Icons for Depth and Complexity, and Content Imperatives, Keys to Questioning, Socratic Seminars, or World Café. Examples of how some of these strategies can be used to extend the learning for advanced and gifted learners in the regular classroom or in a designated GATE classroom are described below.

• **Elements of complexity.** These ideas help students to think about relationships between and among ideas, connect other concepts, and use an interdisciplinary approach to learning content. In science, you might increase the complexity of how students think about a disciplinary core idea by extending the investigation to the study of issues, problems, and themes using these elements:
  
  • Relationships over time—to explain Earth, Moon, Sun relationship; feeding relationships; or how populations change over time.
  
  • Multiple perspectives—to think about different interpretations of data; divergent ideas about a phenomenon or different approaches to a design problem.
  
  • Interdisciplinary relationships—to discuss political aspects of climate change; use of natural resources; ethical questions around engineering.

• **Content imperatives.** Students can also extend and enrich their science learning through the examination of these imperatives: origin, contribution, convergence, paradox, and parallel. For example, you might have students discuss the contributions of scientists to the field of study you are exploring in FOSS.
• **Elements of depth.** These elements help students to examine ideas in science with greater depth—from the concrete to the abstract, from the familiar to the unfamiliar, and from the known to the unknown. Here is how they are used with FOSS:

  - **Language of the discipline**—the vocabulary, tools, and skills that scientists and engineers use to communicate and investigate.
  - **Details**—the scientific knowledge agreed upon in the science community; the parts, attributes, features, or variables of a topic.
  - **Patterns**—the observation of repetitions in the natural and designed world; the predictability of an occurrence.
  - **Trends**—the course of action or direction of something that is to be followed; an examination of the forces/influences at work.
  - **Unanswered questions**—the missing or unclear parts in a science investigation or engineering challenge; the discrepancies of results or incomplete ideas.
  - **Rules**—the guide or procedures for scientific investigation and the engineering design process.
  - **Ethics**—the right or wrong surrounding issues in science and engineering; viewing different opinions/points of view and making judgments.
  - **Big ideas**—the generalizations, or theories/principles of science.

• **Think like a disciplinarian.** Using this strategy, students explore the various concepts associated with the disciplines of science and engineering by assuming the role of different types of scientists and engineers. Students work in pairs, small groups, or independently to focus on one type of scientist or engineer related to the FOSS module. They research aspects of that particular field of science or engineering, approach the investigations from the perspective of that particular type of scientist or engineer, and relate and share information with others. “Think like an engineer” is used in the Energy Module to explore engineering. In the Earth and Sun Module, students discuss the role of a meteorologist. Here are other examples where students could think more deeply about specific science and engineering disciplines.
Water and Climate Module: Climate scientist or hydrologist

Structures of Life Module: Botanist or biologist

Soils, Rocks, and Landforms Module or Earth History Course: Geologist, archaeologist, or soil engineer

Mixtures and Solutions Module: Chemist

Waves Course: Acoustical Engineer

Populations and Ecosystems Course: Ecologist

Planetary Science Course: Astronomer, astrophysicist

- Frames. Students use frames to help them focus on a big idea, clarify their understanding, and push their thinking to higher levels. In FOSS they can be incorporated into the student science notebooks. Students add the concept to be examined in the center of the page. The four bordering quadrants are used to explore the concept and extend the learning.

![Frame with depth and complexity](example_frame.png)

An example of frame with depth and complexity used in the Earth and Sun Module
• **Universal themes.** Similar in purpose to the NGSS crosscutting concepts of science, the universal themes and generalizations are used to make connections between, within, and across disciplines. They are considered the “big ideas” that connect and make sense of all learning. The list of universal themes overlaps with the crosscutting concepts and therefore, can be used in similar ways to increase the complexity of the science and engineering content.

Commonly, one or two of the universal themes are chosen as a focus at each grade level. These can be matched with the crosscutting concepts that are the primary foci of the FOSS modules you are teaching. For example, in grade 5, students using the **Living System Module** focus on the crosscutting concept of systems and system models. They think about systems on different scales—nutrient and transport systems within organisms, feeding relationships in ecosystems, and the environment as a system. The ideas of systems—parts that work together to complete a task—and systems interactions is also important for students to consider in terms of social studies, mathematics, and other areas of study. In grade 8, stability and change is one of the selected crosscutting concepts. Students apply the concept of stability and change to weave together their 8th grade studies, as they consider evidence for evolution in the **Heredity and Adaptation Course**, gravity and stable orbits in the **Gravity and Kinetic Energy Course**, and changes to Earth’s systems in the **Planetary Science Course**.

• **Home and community connections.** Communication with families is key. Knowing the goals and aspiration of your students can help you tailor learning experiences that push their thinking and allow for them to create and innovate in the classroom as well as at home. In addition to the Letter to Family (grades K–5) you can also send home interest surveys for students and their families to discuss and return to you. The FOSS outdoor investigation parts are also great ways to spark ideas for place-based learning opportunities that can involve others in the community.
Students with Disabilities

FOSS is rooted in a 30-year tradition of multisensory science education and informed by recent research on Universal Design for Learning (UDL) in order to provide maximum access for students with disabilities. The instructional design is informed by research and field-testing that was conducted for the Science Activities for the Visually Impaired and Science Enrichment for Learners with Physical Handicaps projects (SAVI/SELPH). Equipment such as the FOSS balance and the modified syringe are products of these explorations into special-education science programs and continue to support access to hands-on science for all students.

Implementing the FOSS program as described in the Investigations Guide provides the first tier of differentiated instruction. The UDL principles serve as the backbone of the instructional design.

Principle 1. Provide multiple means of representation. Give learners various ways to acquire information and knowledge. Throughout the FOSS investigations students are using multiple senses—vision, smell, hearing, and touching to ensure the maximum accessibility for all students.

Principle 2. Provide multiple means of action and expression. Offer students alternatives for demonstrating what they know. The FOSS lesson design allows for students to navigate the science-learning environment and express what they know in different ways.

Principle 3. Provide multiple means of engagement. Help learners get interested, be challenged, and stay motivated. Throughout the investigations, students learn to engage with others in different ways. They sometimes work independently, they work with partners and in collaborative groups of four, and they engage in sense-making discussions as a whole class. The level of engagement is high given the active nature of the investigations.
UDL Guidelines in FOSS. CAST (Center for Applied Special Technology) also created guidelines that provide checkpoints with implementation examples for accommodating students with specific disabilities. The checkpoints are organized into nine types of options for student accommodations: perception, language, comprehension, physical action, expression and communication, executive functions, recruiting interest, sustaining effort and persistence, and self-regulation. Strategies and approaches for each of these areas are embedded in the FOSS instructional design when appropriate. The UDL Guidelines in FOSS on the next pages is a summary of additional suggestions for differentiating FOSS instruction and accommodating the needs of students with specific disabilities as described in the UDL Guidelines Version 2.0. A full description of these strategies can be found on FOSSweb.

Multi-tiered systems of support (MTSS). Schools using the MTSS and/or the Response to Intervention and Instruction (RTI2) method can use these guidelines effectively with the FOSS program.

**Tier 1.** Tier 1 is differentiated instruction for all students in the general education classroom aligned with the UDL principles. Using all the components included in the FOSS instructional design—active investigation, notebooks, assessment, science-centered language development, taking FOSS outdoors, and technology provides this first level of access for all students.

**Tier 2.** For students who need further support, suggestions for next-step strategies, extension activities, and the teaching notes and EL notes provide additional scaffolds and ways to provide targeted and strategic instruction. Use the embedded daily assessments to monitor student learning. Based on that data, plan your next steps, e.g., small group instruction to review key ideas, mini-lessons on ways to organize and analyze data, graphic organizers to look at cause-and-effect relationships, etc. The multimedia activities, virtual investigations, and student tutorials on FOSSweb also support students who may be having difficulties. You can assign online tutorials to individual students, based on how each student answers questions on the I-Checks and Posttest. The Student-by-Item Report, generated by FOSSmap, indicates the tutorials specifically targeted to help individual students to refine their understandings.

**Tier 3.** For students who need intensive intervention, a slower pace, longer period of time, and/or a combination of more than one of the strategies listed in Tier 2 will be required.
### I. Provide Multiple Means of Representation

1. **Provide options for perception.**
   - **Auditory alternatives:**
     - Display or project notebook sheets and teacher masters.
     - Use texts and visuals when communicating orally.
     - Turn on the captions settings when viewing videos.
     - Use the interactive whiteboard flipcharts (IWBs).
   - **Visual alternatives:**
     - Provide auditory descriptions when displaying images.
     - Use physical objects students can touch.
     - Use the audio books on FOSSweb. Access NIMAS files.
     - Remind Star ters to read directions aloud for the group.

2. **Provide options for language, mathematical expressions, and symbols.**
   - Follow the suggestions as described in the Review Vocabulary steps.
   - Consider the EL notes in the margin.
   - Translate idioms, archaic expressions, culturally exclusive phrases, and slang.
   - See the Science-Centered Language Development chapter for a complete discussion on the approaches for vocabulary development in FOSS.

3. **Provide options for comprehension.**
   - Allow sufficient time for reviewing previous learning and experiences (wrap-up/warm-up).
   - Use the suggested graphic organizers.
   - Highlight and review the key points listed in each part.
   - Discuss different ways to answer the focus question.
   - Use next-step strategies.
   - Be explicit and demonstrate how students will use the materials.
   - Model and discuss different options for students to record and organize their data in their notebooks.
   - Have students apply knowledge to engineering extensions, home connections, and art activities.
   - Help students review key ideas using concept maps and connections to ELA derivative products.
   - Discuss the guiding questions at the end of the investigation to generalize the concepts developed in each part.

4. **Provide options for physical action.**
   - Strategically assign the roles of starter or reporter for group work.
   - Break down the physical tasks into smaller parts.
   - Slow down the pacing when necessary and/or reduce the range of motor action required to interact with the materials.
   - Use assistive technologies to allow for students to interact via hand, voice, single switch, joystick, keyboard, or adapted keyboard.

5. **Provide options for expression and communication.**
   - Use notebooks so each student can communicate in his/her own way.
   - Integrate digital technologies with notebooks.
   - Provide the sentence frames in the EL notes for writing and discussions.
   - Use the scaffolds in the guiding steps and gradually release.
   - Provide productive feedback and encourage multiple solutions to the engineering problems.

6. **Provide options for executive functions.**
   - Help students to set goals for themselves using the SEP assessment checklist as a guide.
   - Use the teaching notes and EL notes to prompt students to “stop and think.”
   - Pause for students to share their observations and inferences with partners.
   - Encourage students to explain their reasoning verbally and in writing.
   - Model think-alouds for engaging in the practices and sense-making discussions.
   - Help students manage information and resources by following the suggestions for using graphic organizers and modeling how to organize information.
   - Encourage students to look back through their notebooks to retrieve data they’ve recorded previously.
   - Use the formative assessment component of FOSS for monitoring and providing feedback for students.
   - Follow the guidelines in the Assessment chapter to help students use self-assessment techniques to guide their own efforts, e.g., line of learning.
III. Provide Multiple Means of Engagement

7. Provide options for recruiting interest

- Involve students in making decisions about how to plan and conduct the investigations.
- Help students sustain effort and concentration by referring back to the focus questions, the larger phenomenon, and the driving question for the module.
- Discuss how each new discovery is a piece of the puzzle they are trying to figure out.
- Post the guiding question and add in the underlying focus questions.
- Review and practice norms for maintaining an accepting and supportive classroom climate.
- Adhere to the scheduled times and routines for science.
- Stress the importance of following the rules for materials management and use, and how to care for the living organisms.
- Monitor and adjust according to students’ sensitivity to visual and auditory stimulation.
- Make all students responsible for everyone’s involvement and learning experience in the classroom.

8. Provide options for sustaining effort and persistence.

- Use next-step strategies like “anonymous student work” to guide discussions around expectations and connections to students’ interests and backgrounds.
- Explicitly discuss how students’ work replicates scientists and engineers.
- Differentiate the degree of difficulty or complexity of the investigations by providing various levels of support—either structured, guided or open inquiry. Teaching notes in the margins as well as choices for step options are signals for when to differentiate.
- Review the materials and tools to be used in the investigation to determine whether to provide alternatives, e.g., beakers instead of syringes, using digital thermometers or scales, and review the scaffolds suggested in the EL Notes.
- Follow the collaborative small group structure, stress the group goals, roles, and responsibilities and debrief how well the groups are working together.
- Facilitate “science buddies” where your class works with another grade level that is closely related to the learning progression your class is on.
- Use the embedded assessments to provide students with feedback.
- De-emphasize competition when engaging in the engineering tasks, rather focus on creativity and how well they meet the criteria and work together as a team.
- Use the following UDL examples of appropriate feedback for students with disabilities who may view themselves as constrained by evaluation of their “intelligence” or inherent “abilities.”
  > Encourage perseverance, focus on development of efficacy and self-awareness, and encourage the use of specific supports and strategies in the face of challenge.
  > Emphasize effort, improvement, and achieving a standard rather than relative performance.
  > Be frequent, timely, and specific.
  > Be substantive and informative rather than comparative or competitive.
  > Model how to incorporate evaluation, including identifying patterns of errors and wrong answers, into positive strategies for future success.


- Embed social emotional learning into the science learning experience. To help students stay motivated, provide prompts, reminders, guides, rubrics, checklists that focus on:
  > Self-regulatory goals like reducing the frequency of aggressive outbursts in response to frustration.
  > Increasing the length of on-task orientation in the face of distractions.
  > Elevating the frequency of self-reflection and self-reinforcements.
- Make self-reflection and identification of personal goals part of what students write about in their notebooks and discuss as part of the wrap-up/warm-up routine. See the Assessment chapter in the Investigations Guide for more information.
Students Who Have Difficulties with Literacy

The Science-Centered Language Development chapter describes various strategies for supporting students in science reading and writing, speaking and listening, and language development. Many of these strategies are embedded in the sense-making discussions, notebook entries, vocabulary review, and reading FOSS Science Resources book. For students who would benefit from additional support when tackling higher-level cognitive and language-based tasks in the FOSS investigations, these strategies can be used more frequently.

Strategies for student engagement and classroom support

• **Support cognitive processing** (e.g., self-regulation and memory activation). Conduct think-alouds to demonstrate how to plan an investigation, organize data in notebooks, or design a solution to a problem. Reflect on how to evaluate oral arguments or complex texts. Use self-regulation strategies for following the line of reasoning in sense-making discussions and for reading comprehension. Be specific with instruction on note-making, graphic organizers, and content grids. Allow opportunities for constructive and productive feedback, including from peers.

• **Intensify meaningful interactions.** Use the collaborative grouping structure and roles as described in the *Investigations Guide*. Provide explicit instruction, including clear explanations and teacher modeling as described. When necessary, use the break points in the investigation to break the investigation down into smaller chunks. Assign the roles for group work according to the skill levels of your students, e.g., strong readers should be the starters, strong writers the recorder, strong oral skills the reporter. Be open to teachable moments when students come up with interesting questions that show they are applying what they’ve learned. Encourage students to “think out loud” and push their own thinking in new directions.

• **Attend to disciplinary literacy.** Follow the suggestions in the reading FOSS Science Resources for opportunities to discuss with students how language is used in science and engineering (e.g., vocabulary, text structure and organization, how ideas are “packaged” in sentences and paragraphs) and to explore how science and engineering texts work (e.g., language analysis: unpacking the meanings in grammatically complex sentences; connecting text to information presented in diagrams and graphs; identifying text connectives, nominalization, and other language resources). Follow the steps in the *Investigations Guide*. 
for engaging students in vocabulary/concept building activities and refer to Science-Centered Language Development chapter for more ideas, such as using concept maps, concept-definition maps, concept circles, and other graphic organizers.

**School support systems**

- **Literacy intervention programs.** Programs in the school designed to support literacy should include literacy in science, knowing how to read, write, and speak scientifically.

- **Collaborate with ELA teachers.** Middle school science teachers can work with their ELA, ELD, and social studies colleagues to coordinate around joint projects, common themes, and support for their students. For example, students can use their science notebooks as first drafts for more formal writing experiences in their ELA course.

- **Intensify instructional time in elementary classrooms.** Increase the frequency of FOSS instruction (e.g., use language arts time to read, write, and discuss science and engineering topics related to the FOSS investigation). Doing so allows students to build their literacy skills in a way that supports the learning of both science and language arts standards. Combine allocated language arts time with science time as literacy is developed in context and understanding science develops literacy.

**Home and community connections**

- **Literacy at home.** Include literacy supports for engaging in the science activities at home, such as sending home resources for reading comprehension strategies, writing supports, and vocabulary development activities. Make sure caregivers are aware of the resources on FOSSweb such as audio books, tutorials, and interactive eBooks.

- **Science in the library.** Partner with organizations and groups to help make sure high-quality science books and multimedia are a priority in the school library.
REFERENCES


