GRADES PRE-K–5

Access and Equity

Introduction

FOSS for All Students

Each classroom dynamic differs from year to year. As the teacher, you assess the strengths and needs of your students and then decide on the appropriate methods to support their learning. 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 leverage the assets and support the specific needs of a particular student(s) in one or more of these populations—culturally and linguistically diverse learners, Multilingual learners (students who are acquiring English as an additional language), students living in poverty, students in foster care, girls and young women, highly capable learners, students with disabilities, and students experiencing difficulties with literacy in science and engineering.

While, the strategies may be designed with a specific group of students in mind, they will most likely benefit most if not all the students in your classroom.

CONTENTS

Equity in Science Instruction

When attending to access and equity in your classroom, it's important to consider these four areas.

- **Student engagement**—what motivates and engages students in the science learning.
- **Classroom support strategies**—what the teacher provides in order to ensure access, equity, and inclusion.
- **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.

Areas of Support	FOSS Program Elements
Student Engagement	Active Investigation Collaborative Discussion
Classroom Support Strategies	Universal Design for Learning Language and Literacy Support
School Support Systems	Materials and Equipment Technical Assistance
Home and Community Connections	FOSS Home/School Connection Letters Home

How FOSS supports access and equity (Adapted from Lee, Miller, and Januszyk, 2015)

This chapter will help you provide equitable learning opportunities for your 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 provides 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 strengths and needs of your particular students and provides suggestions for instructional strategies to help students reach their full potential. It answers the questions:

- What are the different populations of students who may benefit from specific instructional approaches?
- What are effective strategies for teaching and learning science in a diverse classroom?

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 you can use the FOSS program to address 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 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.

NOTE
Providing equitable learning opportunities requires knowing the curriculum, understanding the assets and needs of the students in your classroom, and responding effectively.

Equity in Science Instruction

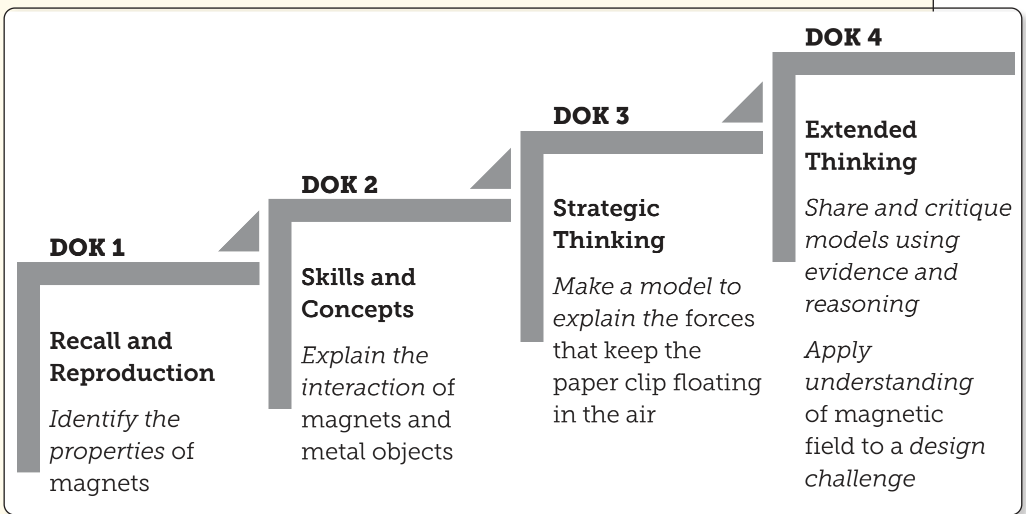
Activity. Exploring phenomena with real materials, objects, systems, and organisms assures engagement for all students. To optimize student interactions, students should be in groups of four facing each other and each child should have a role in conducting the investigation (e.g., getters, recorder, 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 Multilingual 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 their own thinking in their 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 interdisciplinary literacy skills. The next-step strategies can then be used to provide ways to differentiate instruction based on students' learning goals.

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 Module** where 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). Later, they will apply what they have learned about the magnetic field to a design challenge. Highly Capable learners can 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 provides multiple means of student engagement, representation of information, and action and expression. (CAST 2018). These strategies benefit a wide range of students and are discussed later in this chapter.



Examples of each of the DOK levels in the FOSS Motion Module

Equity in Science Instruction

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.
- Integrating 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), using Culturally and Linguistically Responsive Pedagogy (CLRP), and working with special education specialists.

The first goal of FOSS is scientific literacy for all students. It is the first goal because we believe that all students must have access to science in order to build a deeper understanding and appreciation for the world around them.

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 encourage 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 must have 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 to high-quality science instruction.

Planning for Instruction

Planning instruction to meet the needs of all students within the context of science can be challenging. 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 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, using science 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? How can I tap into what students know? 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 the English Language Supports in the margins to provide "just-in-case" scaffolding. 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 uncover student thinking.

- ***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? What was interesting to students?* 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-case" scaffolding during the investigations such as:

NOTE

Culturally and linguistically responsive teaching can be defined as ...

An educator's ability to recognize students' cultural displays of learning and meaning making and to respond positively and constructively with teaching moves that use cultural knowledge as a scaffold to connect what the student knows to new concepts and content. The educator understands the importance of having a social-emotional connection to the student in order to create a safe space for learning.

(Hammond, 2015)

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 disciplinary 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 by focusing on students on the margins. 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 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 phenomena and driving questions for the module
- How the storyline helps students build a conceptual framework in order to explain the phenomena
- How the focus questions for each part build a conceptual framework for students so they can answer it.
- The practices in which students will engage in order to answer the focus questions for each part

Now, think about your students:

- What background knowledge, skills, and experiences do my students have related to this investigation?
- How complex are the tasks? What are the language demands associated with the practices students will engage in?
- How will students engage in sense-making, communicate effectively, and develop their language skills?

- What types of scaffolding, accommodations, or modifications will individual students need to effectively engage in the practices?
- 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 anchor phenomena.
- Model and thoroughly explain the procedures for the investigation.
- Continually monitor for understanding.
- Adjust the sense-making discussions to incorporate strategies that are culturally and linguistically responsive to 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 to deepen student understanding.
- Include the range of visuals that are provided and/or suggested (graphic organizers, diagrams, images, videos, and multimedia on FOSSweb) to aid with comprehension.
- Provide students with language supports 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 core ideas, engage with science and engineering practices, and utilize crosscutting concepts, they will rise to the occasion.

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.

NOTE
See the Sense-Making Discussions for Three-Dimensional Learning chapter for your grade level for more information.

Effective Strategies for Diverse Learners

The table on these 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.

Demographic group	Student engagement and classroom support	School support systems	Home and community connections
Culturally and Linguistically Diverse Learners page 12	High expectations Rapport and affirmation Students' funds of knowledge Identify and dispel stereotypes Culturally compatible learning environments Cooperative learning strategies Contrastive analysis of languages Instructional conversations Disciplinary language development Complex graphic organizers Multiple forms of assessment	Connect to cultures, languages, and experience Validation of home language, e.g., African-American English, Chicano-English, Hawaiian-English, etc. Integrate art Role models and mentors	Know student's culture and language Active participation of families in science learning Community ties and community schools
Multilingual Learners page 17	Active prior knowledge Use comprehensible input Develope academic language Oral discourse practice	Home language support and/or instruction Integrated ELD/science instruction Designated ELD instruction	All of the above plus: Communication with families in home language

Demographic group	Student engagement and classroom support	School support systems	Home and community connections
Students Living in Poverty page 19	Rapport and affirmation Vocabulary development Recognizing effort Growth mindset and resiliency Supporting cognitive processing skills	Health and nutrition Social - Emotional Learning	Foster partnerships
Foster Youth page 22	Rapport and affirmation Provide structure Bridge science experiences Reinforce positive social skills Provide individual attention	Adult mentors—Support buddy system	Support for caregivers Community building
Girls and Young Women page 24	Relevancy Literacy and arts connection Attention to materials, time, and groupings Supporting self-efficacy Motivation Confronting stereotypes Role models	Develop science identity Role models Selecting literature	Sharing resources with families Partnering with organizations
Highly Capable Learners page 26	Strategic grouping Self-direction opportunities Fast pacing Challenge level	School identification programs GATE programs/classes	Sharing resources with families Including families in extended learning projects
Students with Disabilities page 32	Multiple system of supports UDL guidelines	Accommodations and modifications based on students' IEPs Science buddies	Sharing resources with families Partnering with organizations
Students Who Have Difficulties with Literacy page 36	Support information processing Intensify meaningful interactions Attend to disciplinary literacy	Literacy intervention programs Increase instructional time Collaborate with ELA teachers Science buddies	Literacy at home Science in the library

(Adapted from Lee, Miller, and Januszyk, 2015)

Effective Strategies for Diverse Learners

Culturally and Linguistically Diverse Learners

We begin with a focus on students of color who have traditionally been marginalized by the public education system, African-Americans, Latinos, Pacific Islanders, First Nation students, and students of Asian descent such as Hmong, Vietnamese, and Cambodians. The following are research-based approaches from Culturally and Linguistically Responsive Teaching that 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 culturally and linguistically diverse students will be successful. Ways to scaffold the instruction are indicated in the margins of the *Investigations Guide* (see teaching notes and English Language Support). 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 Module**, students are expected to make a cart based on certain criterion and constraints. During their first attempt, the teaching note 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.

- ***Rapport and Affirmation.*** 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. For example, throughout the FOSS investigations you might support students' connection with their environment by caring for plants and animals both inside and outside the classroom, recycling, and solving problems relevant and meaningful to them. Look for suggestions in the extensions section for ways for students to participate in caring for their community and other citizen science projects.

NOTE

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.

- ***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 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.*** 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. See the Careers in Science and Engineering database on FOSSweb.
- ***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 we do better next time?"

Effective Strategies for Diverse 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 formal science language. 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 different 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.

- ***Discplinary 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.

- ***Complex 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.

- ***Multiple forms of 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.)

NOTE

See the Science-Centered Language Development chapter for more on academic language development.

NOTE

For more on culturally responsive teaching, see the work of Geneva Gay, Gloria Ladson-Billings, Sharroky Hollie, and Zaretta Hammond in the Reference section of this chapter.

School support systems

- ***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 discuss the different ways science ideas can be expressed. The goal is for students to use their cultural and linguistic capital to add to the sense-making process.
- ***Connect to cultures, languages, and experience.*** Incorporate culturally relevant 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.
- ***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.

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...

Effective Strategies for Diverse Learners

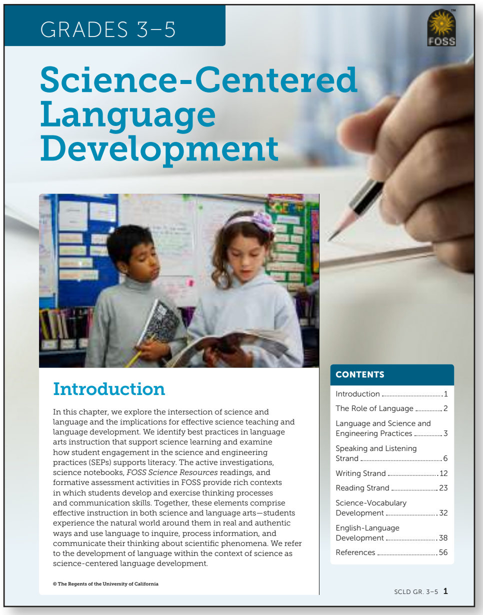
Home and community connections

- ***Know students' cultures.*** Understanding socio-cultural norms of your students' families helps you to develop rapport and affirmation of your students. The home/school connections also 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.
- ***Understanding Language.*** 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
- ***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, side trips 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.

Multilingual Learners

Engaging in the science and engineering practices requires complex language tasks that can be challenging for emergent multilingual 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-case" scaffolds can be found in the strategically placed English Language Support notes within the margins of the *Investigations Guide*. 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 Multilingual 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.


GRADES 3–5

Science-Centered Language Development

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.

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CONTENTS

Introduction 1
The Role of Language 2
Language and Science and Engineering Practices 3
Speaking and Listening Strand 6
Writing Strand 12
Reading Strand 23
Science-Vocabulary Development 32
English-Language Development 38
References 56

SCLD GR. 3–5 1

Strategies for student engagement and classroom support

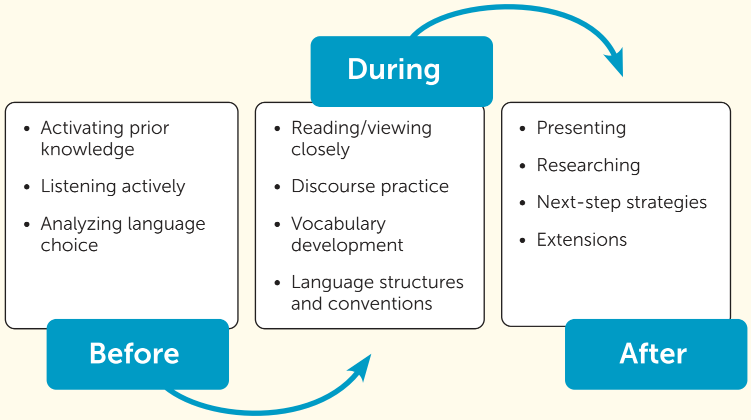
The Science-Centered Language Development chapter describes the strategies listed in the chart below that have proven to be effective in activating students' prior knowledge, ensuring access to the science learning experience (comprehensible input), developing academic language, and supporting productive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

School support systems

In addition to the school support systems described for culturally and linguistically diverse students in the previous section, there are also ways to specifically support multilingual students in science.

Effective Strategies for Diverse 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. Mini-lessons that focus on specific ELD standards can be taught before, during, and after the FOSS science lessons. Science-centered ELD instruction provides students with an engaging context for learning about how English works. Here are some general ideas for using ELD standards to build into and from the science learning. These strategies can be found in the Science-Centered Language Development chapter and corresponding grade-level ELD chapters.



- ***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. If students are in a pull-out program, be sure to coordinate the timing so students do not miss FOSS science instruction. Students learn language best when they are motivated and actively involved in sense-making with their peers.

Home and community connections

In addition to the home and community connections described for culturally and linguistically diverse students in the previous section, here are some additional resources for connecting with families.

- ***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

Here we reiterate and discuss approaches and mindsets that support poverty-responsive teaching and learning—an assets-based perspective, developing partnerships with communities, and a focus on developing interdisciplinary cognitive skills.

English Language Development Strategies Used with FOSS

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

Strategies for student engagement and classroom support

- ***Rapport and affirmation.*** As discussed in the Culturally and Linguistically Diverse Students section, a caring and affirming relationship with students is critical for establishing an inclusive learning environment. Be sure to give students a voice in the science discussions and validate their ideas. (Keep in mind that misconceptions can be starting points for new learning.) While students living in poverty may have less access to resources, they have lived experiences and background knowledge to contribute to the collective science learning experience.
- ***Recognize effort.*** Motivation is key to learning. 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.

Effective Strategies for Diverse Learners

- ***Growth mindset and resiliency.*** Instruction and assessment should be viewed as an opportunity for students 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. Continually reinforce the mindset that students are developing their scientific literacy and are capable of pursuing a career in STEM.
- ***Support cognitive processing skills.*** FOSS investigations are rich, engaging, and intellectually stimulating. If needed, the investigations can be broken up into smaller components to allow time for students to work on information processing skills. Take the time to help students. The instructional design of the investigation includes multiple strategies for students to process information through doing, listening, speaking, reading, and writing. The science notebook is the perfect tool for students to learn and practice 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.*** Make connections to ways to eat healthy - garden vegetables and fruits and be sure to take advantage of the outdoor learning opportunities in the FOSS investigations. 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.*** Attending to the social and emotional welling being of all students is key to building an equitable learning environment. For students who face disruption and stress, or acute distress, SEL is critical. 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.

NOTE

Social Emotional Learning (SEL) is the process through which children and adults acquire and effectively apply the knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions. The Collaborative for Academic, Social, and Emotional Learning, 2017. See CASEL.org for more information on Social Emotional Learning.

Effective Strategies for Diverse Learners

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

- ***Rapport and Affirmation.*** As described in previous sections, understanding a student's living situation and providing as much care and support as possible is critical for providing an equitable learning environment.
- ***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 them 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.

FOSS instruction supports strategies that promote resiliency—caring and supportive relationships, positive and high expectations, and opportunities for meaningful participation in the classroom.

- ***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.*** Students in foster care 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 to help kindergarten students during science time, or a teacher-helper guiding a student in conducting a science fair project. You might 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 care-giver 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 students in foster care 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 care-givers and the teachers of your student's siblings to look for ways to connect their science learning to their combined interests and strengths.

Effective Strategies for Diverse Learners

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 identity 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 inequities related to science and engineering.
- ***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 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.

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.

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 FOSSweb for a list of suggested books.

Effective Strategies for Diverse Learners

- ***Role models.*** Women in STEM 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.

Highly Capable Learners

FOSS provides academic rigor for all students and provides the opportunities for differentiation for highly capable students who have unique needs.

FOSS provides academic rigor for all students and provides the opportunities for differentiation forhighly capable 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 Highly Capable or (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 page 28).

NOTE
The investigation of how to determine speed presents an engineering challenge for students. They will need to engineer a system that enables them to determine the rate each ball travels over a certain distance. There are many different solutions, so encourage students to work through the engineering process.

- ***Different levels of challenges.*** Students can engage in the science and engineering practices at higher levels of complexity in order to deepen and extend their learning of the disciplinary core ideas. They apply complex reasoning to 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. Students might also engage in a ninth practice - Solving problems in novel ways and posing new scientific questions of interest to investigate. (Adams, 2015) 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' high-level thinking capacities. Crosscutting concepts are 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 the reflection on the phenomenon and 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, students explore ecosystems by examening 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 following section on using crosscutting concepts in the Highly Capable or 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.

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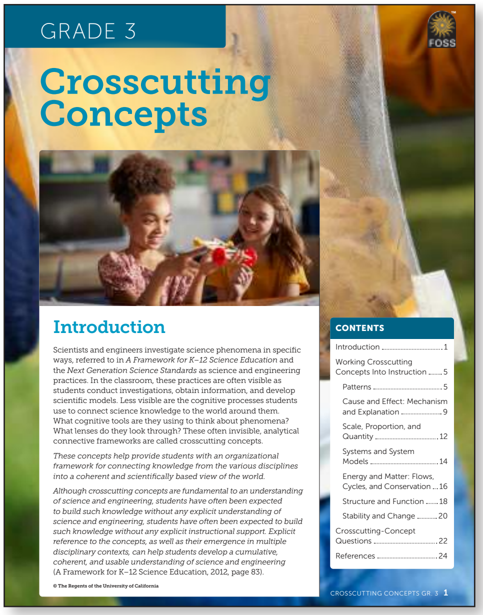
NOTE
See the Crosscutting Concepts chapter for more information.



GRADE 3

FOSS

Crosscutting Concepts

Introduction

Scientists and engineers investigate science phenomena in specific ways, referred to in *A Framework for K–12 Science Education* and the *Next Generation Science Standards* as science and engineering practices. In the classroom, these practices are often visible as students conduct investigations, obtain information, and develop scientific models. Less visible are the cognitive processes students use to connect science knowledge to the world around them. What cognitive tools are they using to think about phenomena? What lenses do they look through? These often invisible, analytical connective frameworks are called crosscutting concepts.

These concepts help provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world.

Although crosscutting concepts are fundamental to an understanding of science and engineering, students have often been expected to build such knowledge without any explicit understanding of science and engineering, students have often been expected to build such knowledge without any explicit instructional support. Explicit reference to the concepts, as well as their emergence in multiple disciplinary contexts, can help students develop a cumulative, coherent, and usable understanding of science and engineering (A Framework for K–12 Science Education, 2012, page 83).

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CONTENTS

CROSSCUTTING CONCEPTS GR. 3 1

Effective Strategies for Diverse Learners

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.

Weather Extensions Menu	
Explore different types of digital weather station tools. Find out from the manufacturer how they are used to collect weather data.	**Investigate** articles related to a weather topic of your choice. Prepare a presentation for the class using visuals or multimedia.
Research how one become a meteorologist. What types of science and math classes does one need to take? How has the occupation changed?	**Student choice**
Create 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).	**Research** weather lore. Over centuries, sayings have evolved to predict the weather. Find and catalog a list of sayings. What are their origins? Are they accurate predictions? Why or why not?

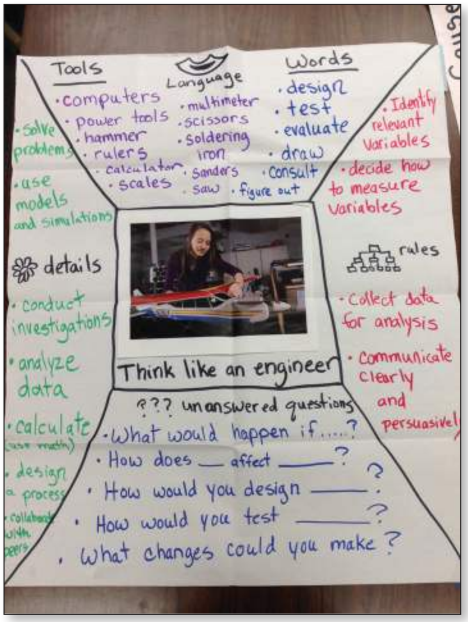
- ***Strategic grouping.*** Periodically mixing up groups is a good idea for the social health of the classroom community; however, keep in mind that the needs of advanced students are better served when they are paired up or placed together in small groups. Consider the cognitive demands of the task and adjust groupings accordingly.

School support systems

Aspects of some of the universal and commonly used strategies for Advanced 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 on the following page.

- ***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.

Effective Strategies for Diverse Learners



An example from the Energy Module "Think like an engineer."

- ***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.

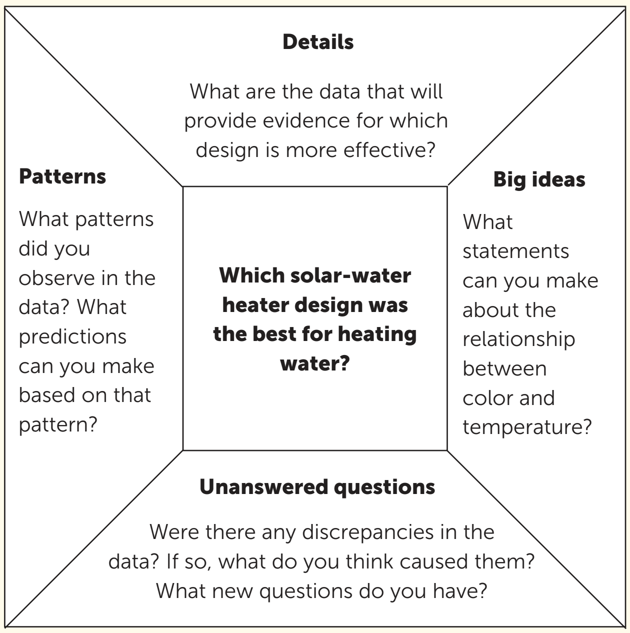
  Water and Climate Module: Climate scientist or hydrologist

  Structures of Life Module: Botanist or biologist

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

  Mixtures and Solutions Module: Chemist

- ***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.



An example of frame with depth and complexity used in the Earth and Sun Module

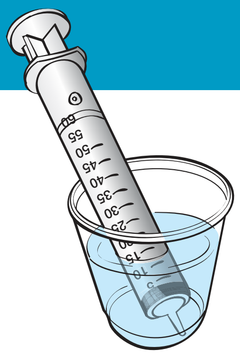
- ***Universal themes.*** Similar in purpose to the NGSS crosscutting concepts of science, the universal themes and generalizations are used to make connections between, within, and across disciplines. They are considered the "big ideas" that connect and make sense of all learning. The list of universal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

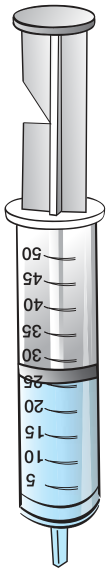
Crosscutting concepts	Universal Themes
Patterns	Patterns
Cause and effect	Relationships
Scale, proportion, and quantity	Relationship or order
Systems and system models	Systems
Energy and matter	Force or influence
Structure and function	Structure
Stability and change	Change

  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—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.

- ***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 T K-5) you can also send home interest surveys for students and their families to discuss and return to you. The FOSS outdoor investigations are also great ways to spark ideas for place-based learning opportunities that can involve others in the community.

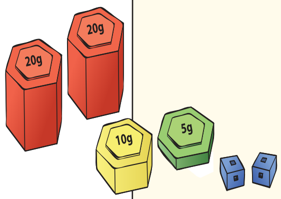
Effective Strategies for Diverse Learners

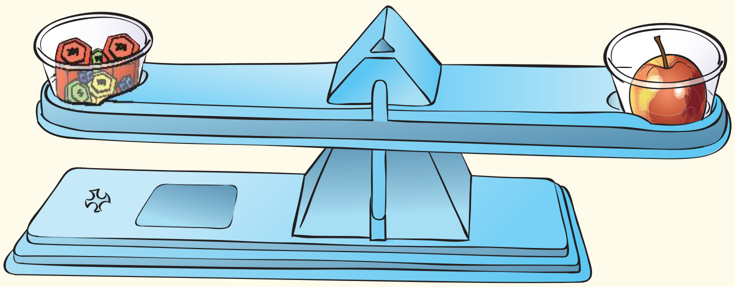




Students with Disabilities

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.

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.

Principle 1. Provide multiple means of engagement. Focus on what is interesting to individual students about the investigation. Help students to sustain effort and persistence as they engage in the science and engineering practices. Use the investigations as opportunities to work on self regulation skills.

Principle 2. Provide multiple means of representation. Give learners various ways to perceive and comprehend information presented to them. Throughout the FOSS investigations students are using multiple senses—, learning the language of science, and constructing meaning in ways that are accessible for each student.

Principle 3. 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.

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 2.2.

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 student.

Tier 2. For students who need further support, suggestions for next-step strategies, extension activities, and the teaching and English Language Support 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.

Effective Strategies for Diverse Learners

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 teaching slides.

Visual alternatives:

- Provide auditory descriptions when displaying images.
- Use physical objects students can touch.
- Use the audio books on FOSSweb. Access NIMAS files.
- Remind Starters 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 English Language Support notes in the margin.
- Translate idioms, archaic expressions, culturally exclusive phrases, and slang.
- See the vocabulary development section of the Science-Centered Language Development chapter.

3. Provide options for comprehension.

- Allow sufficient time for reviewing previous learning and experiences Reflecting on the anchor phenomenon.
- 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.

II. Provide Multiple Means of Action and Expression

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 their own way.
- Integrate digital technologies with notebooks.
- Provide the sentence frames in the English Language Support 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 and English Language Support 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 anchor 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 driving question for the anchor phenomenon 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 English Language Support 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.

9. Provide options for self-regulation.

- 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 reflection. See the Assessment chapter in the Investigations Guide for more information.

Effective Strategies for Diverse Learners

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.

The Science-Centered Language Development chapter describes various strategies for supporting students in science reading and writing, speaking and listening, and language development.

Strategies for student engagement and classroom support

- ***Support information 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, to break the investigation down into smaller chunks to allow more time for processing information. 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 to 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.*** Teachers can work with their 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.

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