INTRODUCTION

Human life is unique, as far as we can tell, because humans have the capacity to design, plan, use history, imagine nonexistent objects, and devise systems of laws and codes of behavior. We have power unknown in other life-forms. But we still share the most fundamental requirements with all other life-forms—nourishment, water, air, space, and suitable environment. Students must understand these facts so that they are prepared to assume responsibility for the well-being of the system of life on Earth.

The Structures of Life Module consists of four investigations dealing with big ideas in life science—plants and animals are organisms and exhibit a variety of strategies for life, organisms are complex and have a variety of observable structures and behaviors, organisms have varied but predictable life cycles and reproduce their own kind, and individual organisms have variations in their traits that may provide an advantage in surviving in the environment. Students observe, compare, categorize, and care for a selection of organisms. Students engage in science and engineering practices to investigate structures and behaviors of the organisms and learn how some of the structures function in growth and survival. Students look at the interactions between organisms of the same kind, among organisms of different kinds, and between the environment and populations over time.
# Structures of Life – Overview

## Module Summary

**Inv. 1: Origin of Seeds**

Students conduct a seed hunt by opening fresh fruit and locating the seeds. They describe and compare seed properties. Students examine and sort a selection of seeds—bean, pea, sunflower, and corn. They investigate the effect water has on seeds by setting up seed sprouters and observing and recording changes over a week. Students systematically find out how much water lima beans soak up in a day. Students investigate seed dispersal mechanisms of plants.

**Inv. 2: Growing Further**

Students examine germinated seeds to determine similarities and differences in the way the organisms grow. They set up a hydroponic garden to observe the life cycle of a bean plant. Students go outdoors to investigate the roots and shoots of various plants. They use tools to dig up plants and compare the structures above ground to those below ground. Through direct experience and readings, students learn about plant structures and functions.

## Focus Questions

- **How are seeds alike and different?**
- **What effect does water have on seeds?**
- **How much water does a seed soak up?**
- **How do seeds disperse away from the parent plant?**
- **What structures does a seedling have to help it grow and survive?**
- **What is the sequence of the bean plant’s life cycle?**
- **How do the roots of schoolyard plants compare to the roots of bean plants?**
<table>
<thead>
<tr>
<th>Content Related to Disciplinary Core Ideas</th>
<th>Reading/Technology</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeds develop in the plant part called a fruit.</td>
<td><strong>Science Resources Book</strong>&lt;br&gt;“The Reason for Fruit”&lt;br&gt;“The Most Important Seed”&lt;br&gt;“Barbara McClintock”&lt;br&gt;“Nature Journal—How Seeds Travel”</td>
<td><strong>Embedded Assessment</strong>&lt;br&gt;Science notebook entry&lt;br&gt;Response sheet&lt;br&gt;Performance assessment</td>
</tr>
<tr>
<td>Different kinds of fruits have different kinds and numbers of seeds; seeds have a variety of properties.</td>
<td><strong>Video</strong>&lt;br&gt;<em>How Seeds Get Here . . . and There</em></td>
<td><strong>Benchmark Assessment</strong>&lt;br&gt;Survey&lt;br&gt;Investigation 1 I-Check</td>
</tr>
<tr>
<td>A seed is an organism, a living thing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeds undergo changes in the presence of water.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A seed contains the embryo plant and stores food. A seed grows into a new plant (reproduction).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed-dispersal mechanisms (wind, water, and animals) move seeds away from parent plants.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germination is the onset of a seed’s development.</td>
<td><strong>Science Resources Book</strong>&lt;br&gt;“Germination”&lt;br&gt;“Life Cycles”</td>
<td><strong>Embedded Assessment</strong>&lt;br&gt;Response sheet&lt;br&gt;Science notebook entry</td>
</tr>
<tr>
<td>Plants need water, light, space, and nutrients to grow.</td>
<td><strong>Videos</strong>&lt;br&gt;<em>How Plants Get Food</em>&lt;br&gt;<em>All about Animal Life Cycles</em></td>
<td><strong>Benchmark Assessment</strong>&lt;br&gt;Investigation 2 I-Check</td>
</tr>
<tr>
<td>The life cycle is the sequence of stages during which a seed grows into an adult (mature) plant and produces seeds, which in turn produce new plants of the same kind.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The fruit of the plant develops from the flower.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots function to take up water and nutrients so they can be transported to other parts of the plant. Different kinds of plants have different root systems.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module Summary

**Inv. 3: Meet the Crayfish**

Students observe and record some of the structures of a crustacean, the crayfish, and compare it to other organisms. They establish a feeding and maintenance schedule for the organisms. Students investigate crayfish behavior and map where the crayfish spend time within their habitat. Through readings, organism cards, and a video, students learn about adaptations of organisms in different environments, including different kinds of group and social behaviors. Students use a computer simulation to study variation of traits in species and explore how variation might affect survival of individuals. Students engage in an outdoor simulation activity to explore food chains.

**Inv. 4: Human Body**

Students observe the articulated human skeletal system in action, use posters and a sense of touch to estimate and refine a count of the 206 human bones, and build skeleton puzzles from memory. Students dissect rodent bones from owl pellets and compare them to human bones. They explore joints and their role in movement focusing on opposable thumbs. Students build operational models of muscle-bone systems to see how muscles move bones. They investigate their skin by making and analyzing fingerprint patterns.

## Focus Questions

**Inv. 3: Meet the Crayfish**

- What are the structures of a crayfish?
- How do crayfish structures and behaviors help crayfish survive?
- What kind of behavior do crayfish display in their habitat?
- How are the structures of crayfish and other animals alike and different?
- What is needed to sustain a food chain?

**Inv. 4: Human Body**

- What are the functions of the skeletal system?
- In what ways are the skeletons of a rodent and a human similar?
- What makes our skeletal system flexible?
- How are fingerprints alike and different?
### Content Related to Disciplinary Core Ideas

- Crayfish have observable structures and behaviors that serve various functions in growth, survival, and reproduction.
- Different organisms can live in different environments; organisms have adaptations that allow them to survive and reproduce in those environments.
- Organisms are related in feeding relationships called food chains.
- Difference in characteristics between individuals of the same species may provide an advantage in surviving.
- Some animals claim a territory that they defend against others of their kind. Some organisms live in social groups that many help the individuals in the group survive.

### Reading/Technology

#### Science Resources Book
- “Crayfish”
- “Adaptations”
- “Life on Earth”
- “Inside a Snail's Shell” (optional)
- “A Change in the Environment”
- “Food Chains”

#### Videos
- All about Animal Adaptations
- All about Animal Behavior and Communication

#### Online Activities
- “Walking Stick Survival”
- “Life Cycles”
- “Crayfish vs. Snail vs. Mantis”
- “Where Does It Live?”
- “What Doesn’t Belong?”
- “Habitat Gallery”
- “Organism Match”

### Assessment

#### Embedded Assessment
- Science notebook entries
- Performance assessment
- Response sheet

#### Benchmark Assessment
- Investigation 3 I-Check

### Content Related to Disciplinary Core Ideas (continued)

- A skeleton is a system of interacting bones. Humans have about 206 bones. Bones have several functions: support, protection, and movement.
- The number and kinds of bones in an organism are characteristics inherited from the parents of the organism.
- Muscles attach across joints to move bones.
- Fossils are important evidence about extinct organisms and past environments.
- Fingerprints can be sorted into three groups based on basic pattern: whorl, arch, and loop.

#### Science Resources Book
- “The Human Skeleton”
- “Barn Owls”
- “Fossils”
- “Skeletons on the Outside”
- “Crayfish, Snails, and Humans”
- “Your Amazing Opposable Thumbs”
- “Joints and Muscles”
- “Fingerprints”
- “Supertwins”

#### Video
- All about Fossils

#### Online Activity
- “Mr. Bones”

#### Embedded Assessment
- Response sheet
- Performance assessment
- Science notebook entry

#### Benchmark Assessment
- Posttest
FOSS COMPONENTS

Teacher Toolkit for Each Module

The FOSS Next Generation Program has three modules for grade 3—Motion and Matter, Structures of Life, and Water and Climate.

Each module comes with a Teacher ToolKit for that module. The Teacher ToolKit is the most important part of the FOSS Program. It is here that all the wisdom and experience contributed by hundreds of educators has been assembled. Everything we know about the content of the module, how to teach the subject, and the resources that will assist the effort are presented here. Each Toolkit has three parts.

Investigations Guide. This spiral-bound document contains these chapters.

- Overview
- Framework and NGSS
- Materials
- Technology
- Investigations (four in this Module)
- Assessment

FOSS Science Resources book. One copy of the student book of readings is included in the Teacher Toolkit.
**Teacher Resources.** These chapters can be downloaded from FOSSweb and are also in the bound *Teacher Resources* book.

- FOSS Program Goals
- Science Notebooks in Grades 3–5
- Science-Centered Language Development
- FOSS and Common Core ELA—Grade 3
- FOSS and Common Core Math—Grade 3
- Taking FOSS Outdoors
- Science Notebook Masters
- Teacher Masters
- Assessment Masters

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**Adaptations**

Look at the animals in one set of Habitat Organism cards. What adaptations do the animals have for movement, getting food, protection, and raising young? Write the names of four different animals and their adaptations in each table. Label the type of environment.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Needs of animal</th>
<th>Animal</th>
<th>Adaptation (structure or behavior)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Movement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Getting food</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protection or defense</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caring for young</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Equipment Kit for Each Module or Grade Level**

The FOSS Program provides the materials needed for the investigations, including metric measuring tools, in sturdy, front-opening drawer-and-sleeve cabinets. Inside, you will find high-quality materials packaged for a class of 32 students. Consumable materials are supplied for two uses before you need to resupply. Teachers may be asked to supply small quantities of common classroom items.
Adaptations

What do porcupines, sea urchins, and cacti have in common? Not the environment in which they live. Porcupines live in the forest, sea urchins live in shallow ocean water, and cacti live in the desert. The answer is that they all have spines. And they have those spines for the same reason. Spines improve the organism’s chances for survival.

Any structure or behavior that improves an organism’s chances for survival is an adaptation. All organisms are able to survive, reproduce, and grow in their environments because they have adaptations.

You already know about several adaptations that crayfish have. Having pincers is an adaptation that helps the crayfish get food. A hard shell is an adaptation that helps the crayfish defend itself against predators. Molting is an adaptation for growing. Carrying eggs under the tail is an adaptation that improves the chances of raising offspring. These are just a few of the adaptations that crayfish have for living in their environment.

Adaptations for Movement

Most animals move in their environment. They need to find food, escape predators, and find mates in order to survive.

Birds fly. Wings and feathers are structures that allow birds to fly. Wings and feathers are adaptations.

Fish swim. Fish have broad tails and fins to move them through the water. Fish have a streamlined shape. Broad tails, fins, and a streamlined shape are adaptations that allow fish to move easily through their environment.

Snakes slither. Snakes have strong muscles that make waves along their bellies. They have scales that give the snake traction. The waves push the snake forward. Strong muscles and scales are adaptations that allow snakes to move through their environment.

Grasshoppers walk, jump, and fly. They have walking legs for moving slowly through the grass. Grasshoppers have strong legs for jumping long distances and wings for flying. Walking legs, jumping legs, and wings are adaptations that allow grasshoppers to move through their environment in these different ways.

Any structure or behavior of an animal that allows it to move in its environment is an adaptation for movement. What adaptations do you have for moving in your environment?
Technology

The FOSS website opens new horizons for educators, students, and families, in the classroom or at home. Each module has digital resources for students and families—interactive simulations, virtual investigations, and online activities. For teachers, FOSSweb provides resources for materials management, general teaching tools for FOSS, purchasing links, contact information for the FOSS Program, and technical support. You do not need an account to view this general FOSS Program information. In addition to the general information, FOSSweb provides digital access to PDF versions of the *Teacher Resources* component of the *Teacher Toolkit* and digital-only resources that supplement the print and kit materials.

Additional resources are available to support FOSS teachers. With an educator account, you can customize your homepage, set up easy access to the digital components of the modules you teach, and create class pages for your students with access to tutorials and online assessments.

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**NOTE**

To access all the teacher resources and to set up customized pages for using FOSS, log in to FOSSweb through an educator account. See the Technology chapter in this guide for more specifics.

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**NOTE**

Look for professional development opportunities and online teaching resources on www.FOSSweb.com.

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Ongoing Professional Learning

The Lawrence Hall of Science and Delta Education strive to develop long-term partnerships with districts and teachers through thoughtful planning, effective implementation, and ongoing teacher support. FOSS has a strong network of consultants who have rich and experienced backgrounds in diverse educational settings using FOSS.
FOSS INSTRUCTIONAL DESIGN

FOSS is designed around active investigations that provide engagement with science concepts and science and engineering practices. Surrounding and supporting those first-hand investigations are a wide range of experiences that help build student understanding of core science concepts and deepen scientific habits of mind.

The Elements of Active Investigation

- Using Formative Assessment
- Integrating Science Notebooks
- Taking FOSS Outdoors
- Engaging in Science–Centered Language Development
- Accessing Technology
- Reading FOSS Science Resources Books
Each FOSS investigation follows a similar design to provide multiple exposures to science concepts. The design includes these pedagogies.

- Active investigation, first-hand experiences with objects, organisms, and materials in the natural and designed worlds
- Recording in science notebooks to answer the focus question
- Reading in FOSS Science Resources books
- Online activities to review or extend the investigation
- Outdoor experiences to collect data from the local environment or apply knowledge
- Assessment to monitor progress and motivate student learning

In practice, these components are seamlessly integrated into a curriculum designed to maximize every student’s opportunity to learn. An instructional sequence may move from one pedagogy to another and back again to ensure adequate coverage of a concept.

A learning cycle is an instructional model based on a constructivist perspective that calls on students to be actively involved in their own learning. The model systematically describes both teacher and learner behaviors in a systematic approach to science instruction.

The most recent model is a series of five phases of intellectual involvement known as the 5Es: Engage, Explore, Explain, Elaborate, and Evaluate. The body of foundational knowledge that informs contemporary learning-cycle thinking has been incorporated seamlessly and invisibly into the FOSS curriculum design.
Active Investigation

Active investigation is a master pedagogy. Embedded within active learning are a number of pedagogical elements and practices that keep active investigation vigorous and productive. The enterprise of active investigation includes

- context: questioning and planning;
- activity: doing and observing;
- data management: recording, organizing, and processing;
- analysis: discussing and writing explanations.

**Context: questioning and planning.** Active investigation requires focus. The context of an inquiry can be established with a focus question or challenge from you or, in some cases, from students. (What effect does water have on seeds?) At other times, students are asked to plan a method for investigation. This might start with a teacher demonstration or presentation. Then you challenge students to plan an investigation, such as to find out how the skeletons of a rodent and a human are similar. In either case, the field available for thought and interaction is limited. This clarification of context and purpose results in a more productive investigation.

**Activity: doing and observing.** In the practice of science, scientists put things together and take things apart, observe systems and interactions, and conduct experiments. This is the core of science—active, firsthand experience with objects, organisms, materials, and systems in the natural world. In FOSS, students engage in the same processes. Students often conduct investigations in collaborative groups of four, with each student taking a role to contribute to the effort.

The active investigations in FOSS are cohesive, and build on each other to lead students to a comprehensive understanding of concepts. Through investigations and readings, students gather meaningful data.

**Data management: recording, organizing, and processing.** Data accrue from observation, both direct (through the senses) and indirect (mediated by instrumentation). Data are the raw material from which scientific knowledge and meaning are synthesized. During and after work with materials, students record data in their science notebooks. Data recording is the first of several kinds of student writing.

Students then organize data so they will be easier to think about. Tables allow efficient comparison. Organizing data in a sequence (time) or series (size) can reveal patterns. Students process some data into graphs, providing visual display of numerical data. They also organize data and process them in the science notebook.
Analysis: discussing and writing explanations. The most important part of an active investigation is extracting its meaning. This constructive process involves logic, discourse, and prior knowledge. Students share their explanations for phenomena, using evidence generated during the investigation to support their ideas. They conclude the active investigation by writing a summary of their learning as well as questions raised during the activity in their science notebooks.

Science Notebooks

Research and best practice have led FOSS to place more emphasis on the student science notebook. Keeping a notebook helps students organize their observations and data, process their data, and maintain a record of their learning for future reference. The process of writing about their science experiences and communicating their thinking is a powerful learning device for students. The science-notebook entries stand as credible and useful expressions of learning. The artifacts in the notebooks form one of the core exhibitions of the assessment system.

You will find the duplication masters for grades 1–5 presented in notebook format. They are reduced in size (two copies to a standard sheet) for placement (glue or tape) into a bound composition book. Full-size duplication masters are also available on FOSSweb. Student work is entered partly in spaces provided on the notebook sheets and partly on adjacent blank sheets in the composition book. Look to the chapter in Teacher Resources called Science Notebook in Grades 3–5 for more details on how to notebooks with FOSS.
Reading in FOSS Science Resources

The FOSS Science Resources books are primarily devoted to expository articles and biographical sketches. FOSS suggests that the reading be completed during language-arts time to connect to the Common Core State Standards for ELA. When language-arts skills and methods are embedded in content material that relates to the authentic experience students have had during the FOSS active learning sessions, students are interested, and they get more meaning from the text material.

Recommended strategies to engage students in reading, writing, speaking, and listening around the articles in the FOSS Science Resources books are included in the flow of Guiding the Investigation. In addition, a library of resources is described in the Science-Centered Language Development chapter in Teacher Resources.

The chapter FOSS and the Common Core ELA in Teacher Resources shows how FOSS provides opportunities to develop and exercise the Common Core ELA practices through science. A detailed table identifies these opportunities in the three FOSS modules for the third grade.

Engaging in Online Activities through FOSSweb

The simulations and online activities on FOSSweb are designed to support students’ learning at specific times during instruction. Digital resources include streaming videos that can be viewed by the class or small groups. Resources may also include virtual investigations and tutorials that students can use to review the active investigations and to support students who need more time with the concepts or who have been absent and missed the active investigations.

The Technology chapter provides details about the online activities for students and the tools and resources for teachers to support and enrich instruction. There are many ways for students to engage with the digital resources—in class as individuals, in small groups, or as a whole class, and at home with family and friends.
Assessing Progress

The FOSS assessment system includes both formative and summative assessments. Formative assessment monitors learning during the process of instruction. It measures progress, provides information about learning, and is predominantly diagnostic. Summative assessment looks at the learning after instruction is completed, and it measures achievement.

Formative assessment in FOSS, called **embedded assessment**, is an integral part of instruction, and occurs on a daily basis. You observe action during class in a performance assessment or review notebooks after class. Performance assessments looks at students’ engagement in science and engineering practices or their recognition of crosscutting concepts, and are indicated with the second assessment icon. Embedded assessment provides continuous monitoring of students’ learning and helps you make decisions about whether to review, extend, or move on to the next idea to be covered.

**Benchmark assessments** are short summative assessments given after each investigation. These **I-Checks** are actually hybrid tools: they provide summative information about students’ achievement, and because they occur soon after teaching each investigation, they can be used diagnostically as well. Reviewing specific items on an I-Check with the class provides additional opportunities for students to clarify their thinking.

The embedded assessments are based on authentic work produced by students during the course of participating in the FOSS activities. Students do their science, and you look at their notebook entries. Bullet points in the Guiding the Investigation tell you specifically what students should know and be able to communicate.

If student work is incorrect or incomplete, you know that there has been a breakdown in the learning/communicating process. The assessment system then provides a menu of next-step strategies to resolve the situation. Embedded assessment is assessment for learning, not assessment of learning.

Assessment of learning is the domain of the benchmark assessments. Benchmark assessments are delivered at the beginning of the module (survey) and at the end of the module (posttest), and after each investigation (I-Checks). The benchmark tools are carefully crafted and thoroughly tested assessments composed of valid and reliable items. The assessment items do not simply identify whether or not a student knows a piece of science content, but identify the depth to which students understand science concepts and principles and the extent to which they can apply that understanding.

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**FOSS Instructional Design**

**TECHNOLOGY COMPONENTS OF THE FOSS ASSESSMENT SYSTEM**

FOSSmap for teachers and online assessment for students are the technology components of the FOSS assessment system. Students in grades 3–5 can take assessments online. FOSSmap provides the tools for you to review those assessments online so you can determine next steps for the class or differentiated instruction for individual students based on assessment performance. See the Assessment chapter for more information on these technology components.
Taking FOSS Outdoors

FOSS throws open the classroom door and proclaims the entire school campus to be the science classroom. The true value of science knowledge is its usefulness in the real world and not just in the classroom. Taking regular excursions into the immediate outdoor environment has many benefits. First of all, it provides opportunities for students to apply things they learned in the classroom to novel situations. When students are able to transfer knowledge of scientific principles to natural systems, they experience a sense of accomplishment.

In addition to transfer and application, students can learn things outdoors that they are not able to learn indoors. The most important object of inquiry outdoors is the outdoors itself. To today’s youth, the outdoors is something to pass through as quickly as possible to get to the next human–managed place. For many, engagement with the outdoors and natural systems must be intentional, at least at first. With repeated visits to familiar outdoor learning environments, students may first develop comfort in the outdoors, and then a desire to embrace and understand natural systems.

The last part of most investigations is an outdoor experience. Venturing out will require courage the first time or two you mount an outdoor expedition. It will confuse students as they struggle to find the right behavior that is a compromise between classroom rigor and diligence and the freedom of recreation. With persistence, you will reap rewards. You will be pleased to see students’ comportment develop into proper field-study habits, and you might be amazed by the transformation of students with behavior issues in the classroom who become your insightful observers and leaders in the schoolyard environment.

Teaching outdoors is the same as teaching indoors—except for the space. You need to manage the same four core elements of classroom teaching: time, space, materials, and students. Because of the different space, new management procedures are required. Students can get farther away. Materials have to be transported. The space has to be defined and honored. Time has to be budgeted for getting to, moving around in, and returning from the outdoor study site. All these and more issues and solutions are discussed in the Taking FOSS Outdoors chapter in Teacher Resources.
Science-Centered Language Development and Common Core State Standards for ELA

The FOSS active investigations, science notebooks, FOSS Science Resources articles, and formative assessments provide rich contexts in which students develop and exercise thinking and communication. These elements are essential for effective instruction in both science and language arts—students experience the natural world in real and authentic ways and use language to inquire, process information, and communicate their thinking about scientific phenomena. FOSS refers to this development of language process and skills within the context of science as science-centered language development.

In the Science-Centered Language Development chapter in Teacher Resources, we explore the intersection of science and language and the implications for effective science teaching and language development. Language plays two crucial roles in science learning: (1) it facilitates the communication of conceptual and procedural knowledge, questions, and propositions, and (2) it mediates thinking—a process necessary for understanding. For students, language development is intimately involved in their learning about the natural world. Science provides a real and engaging context for developing literacy and language-arts skills identified in contemporary standards for English language arts.

The most effective integration depends on the type of investigation, the experience of students, the language skills and needs of students, and the language objectives that you deem important at the time. The Science-Centered Language Development chapter is a library of resources and strategies for you to use. The chapter describes how literacy strategies are integrated purposefully into the FOSS investigations, gives suggestions for additional literacy strategies that both enhance students’ learning in science and develop or exercise English-language literacy skills, and develops science vocabulary with scaffolding strategies for supporting all learners. We identify effective practices in language-arts instruction that support science learning and examine how learning science content and engaging in science and engineering practices support language development.

Specific methods to make connections to the Common Core State Standards for English Language Arts are included in the flow of Guiding the Investigation. These recommended methods are linked to the CCSS ELA through ELA Connection notes. In addition, the FOSS and the Common Core ELA chapter in Teaching Resources summarizes all of the connections to each standard at the given grade level.
DIFFERENTIATED INSTRUCTION

The roots of FOSS extend back to the mid-1970s and the Science Activities for the Visually Impaired and Science Enrichment for Learners with Physical Handicaps projects (SAVI/SELPH). As those special-education science programs expanded into fully integrated settings in the 1980s, hands-on science proved to be a powerful medium for bringing all students together. The subject matter is universally interesting, and the joy and satisfaction of discovery are shared by everyone. Active science by itself provides part of the solution to full inclusion and provides many opportunities at one time for differentiated instruction.

Many years later, FOSS began a collaboration with educators and researchers at the Center for Applied Special Technology (CAST), where principles of Universal Design for Learning (UDL) had been developed and applied. FOSS continues to learn from our colleagues about ways to use new media and technologies to improve instruction. Here are the UDL principles.

**Principle 1.** Provide multiple means of representation. Give learners various ways to acquire information and knowledge.

**Principle 2.** Provide multiple means of action and expression. Offer students alternatives for demonstrating what they know.

**Principle 3.** Provide multiple means of engagement. Help learners get interested, be challenged, and stay motivated.

The FOSS Program has been designed to maximize the science-learning opportunities for students with special needs and students from culturally and linguistically diverse origins. FOSS is rooted in a 30-year tradition of multisensory science education and informed by recent research on UDL. Procedures found effective with students with special needs and students who are learning English are incorporated into the materials and strategies used with all students.

FOSS instruction allows students to express their understanding through a variety of modalities. Each student has multiple opportunities to demonstrate his or her strengths and needs. The challenge is then to provide appropriate follow-up experiences for each student. For some students, appropriate experience might mean more time with the active investigations or online activities. For other students, it might mean more experience building explanations of the science concepts orally or in writing or drawing. For some students, it might mean making vocabulary more explicit through new concrete experiences or
Differentiated Instruction

through reading to students. For some students, it may be scaffolding their thinking through graphic organizers. For other students, it might be designing individual projects or small-group investigations. For some students, it might be more opportunities for experiencing science outside the classroom in more natural, outdoor environments.

The next-step strategies used during the self-assessment sessions after I-Checks provide many opportunities for differentiated instruction. For more on next-step strategies, see the Assessment chapter.

There are additional strategies for providing differentiated instruction. The FOSS Program provides tools and strategies so that you know what students are thinking throughout the module. Based on that knowledge, read through the extension activities for experiences that might be appropriate for students who need additional practice with the basic concepts as well as those ready for more advanced projects. Interdisciplinary extensions are listed at the end of each investigation. Use these ideas to meet the individual needs and interests of your students. In addition, online activities including tutorials and virtual investigations are effective tools to provide differentiated instruction.

English Learners

The FOSS multisensory program provides a rich laboratory for language development for English learners. The program uses a variety of techniques to make science concepts clear and concrete, including modeling, visuals, and active investigations in small groups at centers. Key vocabulary is usually developed within an activity context with frequent opportunities for interaction and discussion between teacher and student and among students. This provides practice and application of the new vocabulary. Instruction is guided and scaffolded through carefully designed lesson plans, and students are supported throughout. The learning is active and engaging for all students, including English learners.

Science vocabulary is introduced in authentic contexts while students engage in active learning. Strategies for helping all students read, write, speak, and listen are described in the Science-Centered Language Development chapter. There is a section on science-vocabulary development with scaffolding strategies for supporting English learners. These strategies are essential for English learners, and they are good teaching strategies for all learners.
FOSS INVESTIGATION ORGANIZATION

Modules are subdivided into investigations (four in this module). Investigations are further subdivided into three to five parts. Each part of each investigation is driven by a focus question. The focus question, usually presented as the part begins, signals the challenge to be met, mystery to be solved, or principle to be uncovered. The focus question guides students’ actions and thinking and makes the learning goal of each part explicit for teachers. Each part concludes with students recording an answer to the focus question in their notebooks.

The investigation is summarized for the teacher in the At-a-Glance chart at the beginning of each investigation.

Investigation-specific scientific background information for the teacher is presented in each investigation chapter organized by the focus questions.

The Teaching Children about section makes direct connections to the NGSS foundation boxes for the grade level—Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts. This information is later presented in color-coded sidebar notes to identify specific places in the flow of the investigation where connections to the three dimensions of science learning appear. The Teaching Children about section ends with information about teaching and learning and a conceptual-flow graphic of the content.

The Materials and Getting Ready sections provide scheduling information and detail exactly how to prepare the materials and resources for conducting the investigation.

Teaching notes and ELA Connections appear in blue boxes in the sidebars. These notes comprise a second voice in the curriculum—an educative element. The first (traditional) voice is the message you deliver to students. The second educative voice, shared as a teaching note, is designed to help you understand the science content and pedagogical rationale at work behind the instructional scene. ELA Connection boxes provide connections to the Common Core State Standards for English Language Arts.

The Getting Ready and Guiding the Investigation sections have several features that are flagged in the sidebars. These include several icons to remind you when a particular pedagogical method is suggested, as well as concise bits of information in several categories.
The safety icon alerts you to potential safety issues related to chemicals, allergic reactions, and the use of safety goggles.

The small-group discussion icon asks you to pause while students discuss data or construct explanations in their groups.

The new-word icon alerts you to a new vocabulary word or phrase that should be introduced thoughtfully.

The vocabulary icon indicates where students should review recently introduced vocabulary.

The recording icon points out where students should make a science-notebook entry.

The reading icon signals when the class should read a specific article in the FOSS Science Resources book.

The technology icon signals when the class should use a digital resource on FOSSweb.

The assessment icons appear when there is an opportunity to assess student progress by using embedded or benchmark assessments. Some are performance assessments—observations of science and engineering practices, indicated by a second icon which includes a beaker and ruler.

The outdoor icon signals when to move the science learning experience into the schoolyard.

The engineering icon indicates opportunities for an experience incorporating engineering practices.

The math icon indicates an opportunity to engage in numerical data analysis and mathematics practice.

The EL note provides a specific strategy to use to assist English learners in developing science concepts.

To help with pacing, you will see icons for breakpoints. Some breakpoints are essential, and others are optional.
MANAGING THE CLASSROOM

Working in Collaborative Groups

Collaboration is important in science. Scientists usually collaborate on research enterprises. Groups of researchers often contribute to the collection of data, the analysis of findings, and the preparation of the results for publication.

Collaboration is expected in the science classroom, too. Some tasks call for everyone to have the same experience, either taking turns or doing the same things simultaneously. At other times, group members may have different experiences that they later bring together.

Research has shown that students learn better and are more successful when they collaborate. Working together promotes student interest, participation, learning, and self-confidence. FOSS investigations use collaborative groups extensively.

No single model for collaborative learning is promoted by FOSS. We can suggest, however, a few general guidelines that have proven successful over the years.

For most activities in upper-elementary grades, collaborative groups of four in which students take turns assuming specific responsibilities work best. Groups can be identified completely randomly (first four names drawn from a hat constitute group 1), or you can assemble groups to ensure diversity. Thoughtfully constituted groups tend to work better.

Groups can be maintained for extended periods of time, or they can be reconfigured more frequently. Six to nine weeks seems about optimum, so students might stay together throughout an entire module.

Functional roles within groups can be determined by the members themselves, or they can be assigned in one of several ways. Each member in a collaborative group can be assigned a number or a color. Then you need only announce which color or number will perform a certain task for the group at a certain time. Compass points can also be used: the person seated on the east side of the table will be the Reporter for this investigation.

The functional roles used in the investigations follow. If you already use other names for functional roles in your class, use them in place of those in the investigations.

**Getters** are responsible for materials. One person from each group gets equipment from the materials station, and another person later returns the equipment.
One person is the **Starter** for each task. This person makes sure that everyone gets a turn and that everyone has an opportunity to contribute ideas to the investigation.

The **Reporter** makes sure that everyone has recorded information on his or her science notebook sheets. This person reports group data to the class or transcribes it to the board or class chart.

Getting started with collaborative groups requires patience, but the rewards are great. Once collaborative groups are in place, you will be able to engage students more in meaningful conversations about science content. You are free to “cruise” the groups, to observe and listen to students as they work, and to interact with individuals and small groups as needed.

**Managing Materials**

The Materials section lists the items in the equipment kit and any teacher supplied materials. It also describes things to do to prepare a new kit and how to check and prepare the kit for your classroom. Individual photos of each piece of FOSS equipment are available for printing from FOSSweb, and can help students and you identify each item.

The FOSS program designers suggest using a central materials distribution system. You organize all the materials for an investigation at a single location called the materials station. As the investigation progresses, one member of each group gets materials as they are needed, and another returns the materials when the investigation is complete. You place the equipment and resources at the station, and students do the rest. Students can also be involved in cleaning and organizing the materials at the end of a session.

**When Students Are Absent**

When a student is absent for a session, give him or her a chance to spend some time with the materials at a center. Another student might act as a peer tutor. Allow the student to bring home a *FOSS Science Resources* book to read with a family member. Each article has a few review items that the student can respond to verbally or in writing.

Students who have been absent from certain investigations can access online activities through FOSSweb. Some of the activities may require students to record data and answer concluding questions in their science notebooks.
SAFETY IN THE CLASSROOM AND OUTDOORS

Following the procedures described in each investigation will make for a very safe experience in the classroom. You should also review your district safety guidelines and make sure that everything you do is consistent with those guidelines. Two posters are included in the kit: *Science Safety* for classroom use and *Outdoor Safety* for outdoor activities.

Look for the safety icon in the Getting Ready and Guiding the Investigation sections that will alert you to safety considerations throughout the module.

Materials Safety Data Sheets (MSDS) for materials used in the FOSS Program can be found on FOSSweb. If you have questions regarding any MSDS, call Delta Education at 1-800-258-1302 (Monday–Friday, 8 a.m.–6 p.m. EST).

Science Safety in the Classroom

General classroom safety rules to share with students are listed here.

1. Listen carefully to your teacher’s instructions. Follow all directions. Ask questions if you don’t know what to do.
2. Tell your teacher if you have any allergies.
3. Never put any materials in your mouth. Do not taste anything unless your teacher tells you to do so.
4. Never smell any unknown material. If your teacher tells you to smell something, wave your hand over the material to bring the smell toward your nose.
5. Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
6. Always protect your eyes. Wear safety goggles when necessary. Tell your teacher if you wear contact lenses.
7. Never release any living things into the environment unless you are told to do so.
8. Always wash your hands with soap and warm water after handling chemicals, plants, or animals.
9. Never mix any chemicals unless your teacher tells you to do so.
10. Report all spills, accidents, and injuries to your teacher.
11. Clean up your work space after each investigation.
12. Act responsibly during all science activities.
SCHEDULING THE MODULE

Below is a suggested teaching schedule for the module. The investigations are numbered and should be taught in order, as the concepts build upon each other from investigation to investigation. We suggest that a minimum of 9.5 weeks be devoted to this module.

Active-investigation (A) sessions include hands-on work with materials and organisms, active thinking about experiences, small-group discussion, writing in science notebooks, and learning new vocabulary in context.

Reading (R) sessions involve reading FOSS Science Resources articles. Reading can be completed during language-arts time to make connections to Common Core State Standards for ELA (CCSS ELA).

During Wrap-Up/Warm-Up (W) sessions, students share notebook entries and engage in connections to CCSS ELA. These sessions can also be completed during language-arts time.

I-Checks are short summative assessments at the end of each investigation. Students have a short notebook review session the day before and a self-assessment of selected items the following day. (See the Assessment chapter for the next-step strategies for self-assessment.)

### SCHEDULING THE MODULE

#### Week Day 1 Day 2 Day 3 Day 4 Day 5

<table>
<thead>
<tr>
<th></th>
<th>Survey</th>
<th>START Inv. 1 Part 1</th>
<th>START Inv. 1 Part 2</th>
<th>START Inv. 2 Part 1</th>
<th>START Inv. 2 Part 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>A</td>
<td>A/R/W</td>
<td>(observe seeds)</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>START Inv. 1 Part 3</td>
<td>(observe seeds)</td>
<td>A</td>
<td>(observe seeds)</td>
<td>END Inv. 1 Part 2</td>
</tr>
<tr>
<td>3</td>
<td>START Inv. 2 Part 1</td>
<td></td>
<td>A</td>
<td>set up hydroponics</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>Self-assess 1</td>
<td></td>
<td>A</td>
<td>A/R/W</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>A</td>
<td>A/R/W</td>
<td>A</td>
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<tr>
<td>6</td>
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<td></td>
<td>A/W</td>
<td>A/R/W</td>
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<tr>
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<td>Review 3</td>
<td>I-Check 3</td>
<td>Self-assess 3</td>
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<td>8</td>
<td></td>
<td>START Inv. 4 Part 2</td>
<td>START Inv. 4 Part 3</td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td></td>
<td>A</td>
<td>A/R/W</td>
<td>A</td>
<td>A</td>
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<tr>
<td>10</td>
<td>START Inv. 4 Part 4</td>
<td></td>
<td></td>
<td></td>
<td>Posttest</td>
</tr>
</tbody>
</table>

**NOTE**

Read through the Getting Ready for Investigations 1 and 2 ahead of time so you know how they are linked and how to plan the schedule for germinating the bean seeds and then planting them hydroponically.

In Investigation 2, students observe the bean plants grow from seedling to mature plant with bean pods and new seeds—the complete life cycle. Investigation 2, Part 1 starts at the beginning of week 3 of instruction (first green box in schedule) and Part 2 starts 6 weeks later, at the beginning of week 9 (first green box week 9). Plan to go on to Investigations 3 and 4 before finishing Investigation 2.

Be prepared—read the Getting Ready section thoroughly and review the teacher preparation video on FOSSweb.
FOSS Contacts

General FOSS Program Information
www.FOSSweb.com
www.DeltaEducation.com/FOSS

Contact the developers at the Lawrence Hall of Science
foss@berkeley.edu

Customer Service at Delta Education
http://www.DeltaEducation.com/contact.aspx
Phone: 1-800-258-1302, 8:00 a.m.–5:00 p.m. ET

FOSSmap (Online component of FOSS assessment system)
http://fossmap.com/

FOSSweb account questions/help logging in
School Specialty Online Support
loginhelp@schoolspecialty.com
Phone: 1-800-513-2465, 8:30 a.m. –6:00 p.m. ET
5:30 a.m.–3:00 p.m. PT

FOSSweb Tech Support
support@fossweb.com
Phone: 1-510-643-6997, 6:30 a.m. –2:30 p.m. ET
9:30 a.m.–5:30 p.m. PT

Professional development
http://www.FOSSweb.com/Professional-Development

Safety issues
www.DeltaEducation.com/MSDS.shtml
Phone: 1-800-258-1302, 8:00 a.m.–5:00 p.m. ET
For chemical emergencies, contact Chemtrec 24 hours per day.
Phone: 1-800-424-9300

Sales and Replacement Parts
www.DeltaEducation.com/BuyFOSS
Phone: 1-800-338-5270, 8:00 a.m.–5:00 p.m. ET