INTRODUCTION

The anchor phenomenon for the Structures of Life Module is the diversity of plants and animals we observe in our world. Students experience that organisms exhibit a variety of strategies for life, have a variety of observable structures and behaviors, have varied but predictable life cycles, and reproduce their own kind by passing inherited characteristics to offspring. Students explore how individual organisms have variations in their traits that may provide an advantage in surviving in a particular environment, and how our knowledge of animals that survived in past environments is inferred by studying fossil characteristics. The driving questions for the module are where do organisms come from, how do they survive, and how are all the different kinds of plants and animals able to continue to exist on Earth?

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, survival, and reproduction. Students look at the interactions between organisms of the same kind, among organisms of different kinds, and between the environment and populations over time. Students focus on these crosscutting concepts to develop understandings about organisms and population survival—patterns; cause and effect; scale, proportion, and quantity; systems and system models; structure and function; and stability and change.
### Investigation Summary

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inv. 1: Origin of Seeds</td>
<td>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.</td>
</tr>
<tr>
<td>Inv. 2: Growing Further</td>
<td>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.</td>
</tr>
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</table>

### Guiding and Focus Questions for Phenomena

<table>
<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
<td>What are seeds and what happens to them?</td>
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<tr>
<td>How are seeds alike and different?</td>
</tr>
<tr>
<td>What effect does water have on seeds?</td>
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<tr>
<td>How much water does a seed soak up?</td>
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<tr>
<td>How do seeds disperse away from the parent plant?</td>
</tr>
<tr>
<td>How do plants grow and survive?</td>
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<tr>
<td>What structures does a seedling have to help it grow and survive?</td>
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<tr>
<td>What is the sequence of the bean plant’s life cycle?</td>
</tr>
<tr>
<td>How do the roots of schoolyard plants compare to the roots of bean plants?</td>
</tr>
</tbody>
</table>
### Content Related to Disciplinary Core Ideas
- Seeds develop in the plant part called a fruit.
- Different kinds of fruits have different kinds and numbers of seeds; seeds have a variety of characteristics.
- A seed is an organism, a living thing.
- Seeds undergo changes in the presence of water.
- A seed contains the embryo plant and stores food.
- Seed-dispersal mechanisms (wind, water, and animals) move seeds away from parent plants.

### Reading/Technology
**Science Resources Book**
- “The Reason for Fruit”
- “The Most Important Seed”
- “Barbara McClintock”
- “Nature Journal—How Seeds Travel”

**Video**
- *How Seeds Get Here . . . and There*

**Online Activity**
- “Plant Basic Needs”

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

**Benchmark Assessment**
- Survey
- Investigation 1 I-Check

**NGSS Performance Expectations**
- 3-LS1-1
- 3-LS3-1

### Content Related to Disciplinary Core Ideas
- Germination is the onset of a seed’s development.
- Plants need water, light, space, and nutrients to grow.
- 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.
- The fruit of the plant develops from the flower.
- 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.

**Science Resources Book**
- “Germination”
- “Life Cycles”

**Videos**
- *How Plants Get Food*
- *All about Animal Life Cycles*

**Online Activity**
- “Structure and Function of Plants” (optional)

**Embedded Assessment**
- Response sheet
- Science notebook entry

**Benchmark Assessment**
- Investigation 2 I-Check

**NGSS Performance Expectations**
- 3-LS1-1
- 3-LS3-1
- 3-LS3-2
### Investigation 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.

### Guiding and Focus Questions for Phenomena

**What are characteristics that allow populations of animals to survive and reproduce in an environment?**

**What are the structures of a crayfish?**

**How do crayfish structures and behaviors help crayfish survive?**

**How does variation in traits among individuals of a species affect survival?**

**What kind of behavior do crayfish display in their habitat?**

**How are the characteristics of crayfish and other animals alike and different?**

**What is needed to sustain a food chain?**

**How are characteristics similar to and different from parents to offspring?**

**What can we learn about animals that lived in the past by looking at their skeletons?**

**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 (characteristics that are structures of behaviors) that allow them to survive and reproduce in those environments.
- Each kind of organism has characteristics inherited from its parents; other characteristics are the result of the environment.
- Differences in characteristics (variation of traits) between individuals of the same species may provide an advantage in surviving.
- Organisms are related in feeding relationships called food chains.
- Some animals claim a territory that they defend against others of their kind. Some organisms live in social groups that may help the individuals in the group survive (to obtain food or defend themselves).

- 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. The offspring may exhibit variations.
- 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.

### Reading/Technology

**Science Resources Book**
- "Crayfish"
- "Adaptations"
- "Life on Earth"
- "Inside a Snail's Shell" (optional)
- "A Change in the Environment"
- "Food Chains"
**Online Activities**
- "Animals Basic Needs"
- "Walking Stick Survival"
- "Life Cycles"
- "Crayfish vs. Snail vs. Mantis"
- "Where Does It Live?"
- "What Doesn't Belong?"
- "Habitat Gallery"
- "Organism Match"

**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"

### Assessment

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

**Benchmark Assessment**
- Investigation 3 I-Check

**NGSS Performance Expectations**
- 3-LS2-1
- 3-LS3-1
- 3-LS3-2
- 3-LS4-2
- 3-LS4-3
- 3-LS4-4
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

Investigation 1: Origin of Seeds

Guiding the Investigation

Part 3: Seed Soak

1. Discuss changes to the seeds.
   After students have had a session or two to observe changes to the seeds, invite them to share their observations. Lead them to draw their observations on the board. Emphasize that the water they are adding to the seeds may add to their changes in appearance.

2. Introduce the investigation
   Introduce the big question the class will be exploring: How much water do these seeds absorb? Ask students to think about what the balance, label the parts of the balance, and explain how to use it, and make an investigation that will help answer those questions. Ask:
   - How can we make a balance that is level or one that is not level?
   - How can we use a balance to find out how much water the seeds have absorbed?

3. Focus question: How much water does a seed soak up?
   Have students design the investigation. Pose questions as needed.

4. Design an investigation
   Encourage students to draw their ideas on how they could investigate the focus question. Tell them you have some equipment they can use to help them conduct their investigations. Share the balance and the materials.

5. Introduce the seed.
   Ask students to design an investigation to find out how much water the seeds absorb. They may use their own ideas or the ideas they developed earlier. Ask them to share their ideas in their notebooks and record their questions in the margin.

6. Share the results
   Ask students to share their results. Remind them to compare their results with their neighbors and to discuss any differences in their results.

7. Reflect and extend
   Discuss the results of the investigation.

8. Add water and store seeds until tomorrow.
   Add enough water to make sure the beans are well-watered, but not so much that the beans are submerged. Have students record how many days the seeds were soaked. Have students record how many days the seeds were soaked. Have students record how much water the beans absorbed.

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**FOSS Components**

**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 most are also in the bound Teacher Resources book.

- FOSS Program Goals
- Planning Guide—Grade 3
- Science and Engineering Practices—Grade 3
- Crosscutting Concepts—Grade 3
- Sense-Making Discussions for Three-Dimensional Learning—Grade 3
- Access and Equity
- 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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### 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 three uses before you need to resupply. Teachers may be asked to supply small quantities of common classroom materials.

Delta Education can assist you with materials management strategies for schools, districts, and regional consortia.

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*Structures of Life Module—FOSS Next Generation*
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 three 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 online teacher Investigation Guides; grade-level planning guides (with connections to ELA and math); materials management strategies; science teaching and professional development tools; contact information for the FOSS Program developers; and technical support. In addition FOSSweb provides digital access to PDF versions of the Teacher Resources component of the Teacher Toolkit, digital-only instructional resources that supplement the print and kit materials, and access to FOSSmap, the online assessment and reporting system for grades 3–8.

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.

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.

Structures of Life Module—FOSS Next Generation
FOSS INSTRUCTIONAL DESIGN

FOSS is designed around active investigation that provides 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 the FOSS Instructional Design

- Using Formative Assessment
- Integrating Science Notebooks
- Taking FOSS Outdoors
- Engaging in Science–Centered Language Development
- Accessing Technology
- Reading FOSS Science Resources Books

Active Investigation
Each FOSS investigation follows a similar design to provide multiple exposures to science concepts. The design includes these pedagogies.

- Active investigation in collaborative groups: firsthand experiences with phenomena in the natural and designed worlds
- Recording in science notebooks to answer a focus question dealing with the scientific phenomenon under investigation
- Reading informational text in FOSS Science Resources books
- Online activities to acquire data or information or to elaborate and extend the investigation
- Outdoor experiences to collect data from the local environment or to apply knowledge
- Assessment to monitor progress and inform student learning

In practice, these components are seamlessly integrated into a curriculum designed to maximize every student’s opportunity to learn.

A learning cycle employs 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 coherent approach to science instruction.

A popular model describes a sequence 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.

Engagement with real-world phenomena is at the heart of FOSS. In every part of every investigation, the investigative phenomenon is referenced implicitly in the focus question that guides instruction and frames the intellectual work. The focus question is a prominent part of each lesson and is called out for the teacher and student. The investigation Background for the Teacher section is organized by focus question—the teacher has the opportunity to read and reflect on the phenomenon in each part in preparing for the lesson. Students record the focus question in their science notebooks, and after exploring the phenomenon thoroughly, explain their thinking in words and drawings.

In science, a phenomenon is a natural occurrence, circumstance, or structure that is perceptible by the senses—an observable reality. Scientific phenomena are not necessarily phenomenal (although they may be)—most of the time they are pretty mundane and well within the everyday experience. What FOSS does to enact an effective engagement with the NGSS is thoughtful selection of scientific phenomena for students to investigate.
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**: sharing prior knowledge, questioning, and planning;
- **activity**: doing and observing;
- **data management**: recording, organizing, and processing;
- **analysis**: discussing and writing explanations.

**Context: sharing, questioning, and planning.** Active investigation requires focus. The context of an inquiry can be established with a focus question about a phenomenon 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 in their science notebooks, as well as proposing answers to questions raised during the activity.

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-sized masters for grades 3–5 that can be filled in electronically (one's function (what the structure helps the mealworm do).)

Mealworm Observations

1. Observe the structures of a mealworm.
2. Observe a mealworm and label its structures (parts of body).
3. List three mealworm structures. Describe each one's function (what the structure helps the mealworm do).
4. Observe and describe the mealworm's behavior (what it does).
5. What questions do you have about mealworms?
6. What do you need to know about the mealworm to keep it alive and healthy in the classroom?
7. Six legs are for walking.
8. Segmented body provides protection.
9. Antennae are feelers to sense the environment.
10. Segmented body on head.
Reading in FOSS Science Resources

The FOSS Science Resources books, available in print and interactive eBooks, 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 FOSS and Common Core ELA—Grade 3 chapter 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.

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 observe the actions and look at their notebook entries. Bullet points in the Guiding the Investigation tell you specifically what students should know and be able to communicate.

Benchmark assessments include the Survey, I-Checks, Posttest, and interim assessments. The Survey is given before instruction begins. It provides information about students’ prior knowledge. I-Checks are actually hybrid tools: they can provide summative information about students’ achievement, but more importantly, they can be used formatively as well to provide diagnostic information. Reviewing specific items on an I-Check with the class provides additional opportunities for students to clarify their thinking. The Posttest is a summative assessment given after instruction is complete.

Interim assessments give students practice with items specifically designed to measure three-dimensional learning described by NGSS performance expectations. Interim assessment tasks generally begin with a scenario, and ask students to apply practices and crosscutting concepts as well as disciplinary core ideas to respond to the item. Interim assessment tasks can be administered during a module, at the end of the module, or as an end-of-year grade-level assessment.

All benchmark items are carefully designed to be valid, reliable, and accessible to all students. They focus on assessment for learning, and when accompanied by thoughtful self-assessment activities and feedback, contribute to the development of a growth mindset.
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 Teacher Resources summarizes all of the connections to each standard at the given grade level.
DIFFERENTIATED INSTRUCTION FOR ACCESS AND EQUITY

Learning from Experience

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 Program). As this special-education science program expanded into fully integrated (mainstreamed) 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 the same 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 guiding principles.

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


FOSS for All Students

The FOSS Program has been designed to maximize the science learning opportunities for all students, including those who have traditionally not had access to or have not benefited from equitable science experiences—students with special needs, ethnically diverse learners, English learners, students living in poverty, girls, and advanced and gifted learners. FOSS is rooted in a 30-year tradition of multisensory science education and informed by recent research on UDL and culturally and linguistically responsive teaching and learning. 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 during the initial instruction phase. In addition, the Access and Equity chapter in Teacher Resources (or go to FOSSweb to download this chapter) provides strategies and suggestions for enhancing the science and engineering experiences for each of the specific groups noted above.

Throughout the FOSS investigations, students experience multiple ways of interacting with phenomena and expressing their understanding through a variety of modalities. Each student has multiple opportunities to demonstrate his or her strengths and needs, thoughts and aspirations. The challenge is then to provide appropriate follow-up experiences or enhancements appropriate for each student. For some students, this might mean more time with the active investigations or online activities. For other students, it might mean more experience and/or scaffolds for developing models, building explanations, or engaging in argument from evidence.

For some students, it might mean making vocabulary and language structures more explicit through new concrete experiences or through reading to students. It may help them identify and understand relationships and connections through graphic organizers.

For other students, it might be designing individual projects or small-group investigations. It might be more opportunities for experiencing science outside the classroom in more natural, outdoor environments or defining problems and designing solutions in their communities.
Assessment and Extensions

The next-step strategies suggested during the self-assessment sessions following I-Checks provide opportunities for differentiated instruction. These strategies can also be used to provide targeted and strategic instruction for students who need additional specific support. For more on next-step strategies, see the Assessment chapter.

There are additional approaches and strategies for ensuring access and equity by providing appropriate differentiated instruction. The FOSS Program provides tools and strategies so that you know what students are thinking throughout the module. Based on that knowledge and what you know about your students’ cultural and linguistic background, as well as their individual strengths and needs, read through the extension activities for additional ways to enhance the learning experience for your students. Interdisciplinary extensions in the arts, social studies, math, and language arts, as well as more advanced projects 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 levels of instruction.

English Learners

The FOSS Program provides a rich laboratory for language development for English learners. A variety of techniques are provided to make science concepts clear and concrete, including modeling, visuals, and active investigations in small groups. Instruction is guided and scaffolded through carefully designed lesson plans, and students are supported throughout.

Science vocabulary and language structures are introduced in authentic contexts while students engage in hands-on learning and collaborative discussion. Strategies for helping all students read, write, speak, and listen are described in the Science-Centered Language Development chapter. A specific section on English learners provides suggestions for both integrating English language development (ELD) approaches during the investigation and for developing designated (targeted and strategic) ELD-focused lessons that support science learning.
FOSS INVESTIGATION ORGANIZATION

Modules are subdivided into investigations (four in this module). Investigations are further subdivided into three to five parts. Each investigation has a general guiding question for the phenomenon students investigate, and each part of each investigation is driven by a specific focus question. The focus question, usually presented as the part begins, engages the student with the phenomenon and 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 Connections boxes provide connections to the Common Core State Standards for English Language Arts.

FOCUS QUESTION

What is the sequence of the bean plants' life cycle?

SCIENCE AND ENGINEERING PRACTICES

Analyzing and interpreting data

DISCIPLINARY CORE IDEAS

LS1.B: Growth and development of organisms

CROSSCUTTING CONCEPTS

Structure and function

TEACHING NOTE

This focus question can be answered with a simple yes or no, but the question has power when students support their answers with evidence. Their answers should take the form “Yes, because ____.”
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 **crosscutting concepts** icon indicates an opportunity to expand on the concept by going to *Teacher Resources, Crosscutting Concepts* chapter. This chapter provides details on how to engage students with that concept in the context of the investigation.

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.
ESTABLISHING A CLASSROOM CULTURE

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, language development, and self-confidence. FOSS investigations use collaborative groups extensively. Here are a few general guidelines for collaborative learning 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 and inclusion. Thoughtfully constituted groups tend to work better.

Groups can be maintained for extended periods of time, or they can be reconfigured 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.

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

The **Recorder** makes sure that everyone has recorded information in his or her science notebook and, as appropriate, records the group data and ideas.

The **Reporter** reports group data to the class or transcribes it to the board or class chart, and shares the main points of the group discussion during class discussion.

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 in more 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.

### Norms for Sense-Making Discussions

Setting up norms for discussion and holding yourself and your students accountable is the first step towards creating a culture of productive talk in the classroom that supports engagement in the science and engineering practices. Students need to feel free to express their ideas, and to provide and receive criticism from others as they work toward understanding of the disciplinary core ideas of science and methods of engineering.

Establish norms at the beginning of the school year. It is recommended that this be done together as a class activity; however, presenting a poster of norms to students and asking them to discuss why each one is important can also be effective. Before each sense-making discussion, review the norms. Review what it will look like, sound like, and feel like when everyone is following the agreements. You might have students work on one or two at a time as they are developing their oral discourse skills. After discussion, save a few minutes for reflection on how well the group or the class adhered to the norms and what they can do better next time. More strategies for supporting academic discourse can be found in the chapters Sense-Making Discussions for Three-Dimensional Learning and Science-Centered Language Development in *Teacher Resources* (also available as downloadable PDFs on FOSSweb).
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. Classroom volunteers and helpful students can also assist in setting up and preparing the materials.

Individual photos of each piece of FOSS equipment are available for printing from FOSSweb, and can help students and you identify each item. They can be used to support emerging readers and English language learners acquire and use new vocabulary words necessary to engage in the investigations. (Photo equipment cards are available in English and Spanish formats.)

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. Be sure to work with students to Reduce, Reuse, and Recycle the materials used in science.

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. There are suggested interactive reading strategies for each article as well as embedded review items that the student can respond to verbally or in writing.

There is a set of two or three virtual investigations for each FOSS module for grades 3–5. Students who have been absent from certain investigations can access these simulations online through FOSSweb. The virtual investigations require students to record data and answer concluding questions in their science notebooks. Sometimes the notebook sheet that was used in the classroom investigation is also used for the virtual investigation.
Collaborative Teaching and Learning

Collaborative learning requires a collective as well as individual growth mindset. A growth mindset is when people believe that their most basic abilities can be developed through dedication and hard work (see the research of Carol Dweck and her book *Mindset: The Psychology of Success*). As students work together to make sense of phenomena and develop their inquiry and discourse skills, it’s important to recognize and value their efforts to try new approaches and their willingness to make their thinking visible. Remind students that everyone in the classroom, including you the teacher, will be learning new ideas and ways to think about the world. Where there is productive struggle, there is learning. Here are a few ways to help students develop a growth mind-set for science and engineering.

- **Praise effort, not right answers.** When students are successful at a task, provide positive feedback about their level of engagement and effort in the practices, e.g., the efforts they put into careful observations, how well they organized and interpreted their data, the relevancy of their questions, how well they connected or applied new concepts, and their use of precise vocabulary, etc. Also, try to provide feedback that encourages students to continue to improve their learning and exploring, e.g., is there another way to approach this question? Have you thought about ____? What evidence is there to support ____?

- **Foster and validate divergent thinking.** During sense-making discussions, continually emphasize how important it is to share emerging ideas and to be open to the ideas of others in order to build understanding. Model for students how you refine and revise your thinking based on new information. Make it clear to students that the point is not for them to show they have the right answer, but rather to help each other arrive at new understanding. Point out positive examples of students expressing and revising their ideas.

Establishing a classroom culture that supports three-dimensional teaching and learning centers on collaboration. Collaborative groupings, materials management, and norms are structures you can put into place to foster collaboration. These structures along with the expectations that students will be negotiating meaning together as a community of learners, creates a learning environment where students are compelled to work, think, and communicate like scientists and engineers to help one another learn.
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.

Safety Data Sheets (SDS) for materials used in the FOSS Program can be found on FOSSweb. If you have questions regarding any SDS, 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. Always protect your eyes. Wear safety goggles when necessary. Tell your teacher if you wear contact lenses.
5. 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.
6. Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
7. Always wash your hands with soap and warm water after handling chemicals, plants, or animals.
8. Never mix any chemicals unless your teacher tells you to do so.
9. Report all spills, accidents, and injuries to your teacher.
10. Treat animals with respect, caution, and consideration.
11. Clean up your work space after each investigation.
12. Act responsibly during all science activities.

Science Safety

Listen carefully to your teacher’s instructions. Follow all directions. Ask questions if you don’t know what to do.

Tell your teacher if you have any allergies.

Never put any materials in your mouth.

Dress appropriately for the weather and the outdoor experience.

Stay within the designated study area and with your partner or group.

Know if there are any skin-irritating plants in your schoolyard, and do not touch them. Most plants in the schoolyard are harmless.

Respect all living things. When looking under a stone or log, lift the side away from you so that any living thing can escape.

If a stinging insect is near you, stay calm and slowly walk away from it. Tell your teacher right away if you are stung or bitten.

Never release any living things into the environment unless you collected them there.

Always wash your hands with soap and warm water after handling plants, animals, and soil.

Return to the classroom with all of the materials you brought outside.
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 next-step strategies for self-assessment.)

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Study 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 on week 3, but ends 6 weeks later at the beginning of 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
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/access codes/help logging in
techsupport.science@schoolspecialty.com
Phone: 1-800-258-1302, 8:00 a.m.–5:00 p.m. ET

School Specialty online support
loginhelp@schoolspecialty.com
Phone: 1-800-513-2465, 8:30 a.m. –6:00 p.m. ET

FOSSweb tech support
support@fossweb.com

Professional development
www.FOSSweb.com/Professional-Development

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

Sales and replacement parts
www.DeltaEducation.com/FOSS/buy
Phone: 1-800-338-5270, 8:00 a.m.–5:00 p.m. ET