INTRODUCTION

This module provides experiences that help students develop an understanding of how to observe and manipulate the phenomena of sound and light. They explore these dimensions of the natural world using simple tools and musical instruments. The driving question for the module is how do sound and light interact with objects?

Students learn that sound comes from vibrating objects. They explore how to change sound volume and pitch, and develop simple models for how sound travels from a source to a receiver. With light, students also work with sources and receivers. They find out what happens when materials with different properties are placed in a beam of light, and explore how to create and change shadows and reflections. Students explore how to use sound and light devices to communicate information and compare the ways that animals use their senses (ears and eyes) to gather information about their environment.

Throughout the Sound and Light Module, students engage in science and engineering practices by collecting data and designing and using tools to solve problems and answer questions. Students gain experiences that contribute to their understanding of the crosscutting concepts: patterns; cause and effect; and systems and system models.

The NGSS Performance Expectations addressed in this module include:

Physical Sciences
1-PS4-1
1-PS4-2
1-PS4-3
1-PS4-4

Engineering, Technology, and Applications of Science
K–2 ETS1-1
K–2 ETS1-2
K–2 ETS1-3

NOTE
The three modules for grade 1 in FOSS Next Generation are

Sound and Light
Air and Weather
Plants and Animals
<table>
<thead>
<tr>
<th>Module Summary</th>
<th>Guiding and Focus Questions for Phenomena</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inv. 1: Sound and Vibrations</strong></td>
<td></td>
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</tbody>
</table>
Students observe the phenomenon of sound using a table fiddle, tuning forks, a tone generator, cups, sticks, and rubber bands. Students look for vibrations at the sound source and come up with words to describe different sounds. They learn how to discriminate between different kinds of sounds and what information sounds convey. Students find out about sounds that different animals make. |  
**What is sound?**  
What causes sound?  
What kinds of sounds are easy to identify?  
What information does sound give us? |
| **Inv. 2: Changing Sound** |  
Students use simple instruments (xylophone, one-string guitar) to investigate how to change the volume of sound (loud and soft) and the pitch of sound (high and low). Using a spoon gong, students develop a model to explain the phenomenon of sound traveling from a source to a receiver. They redesign the spoon gong to make a device to both send and receive sound. Students learn about sound receivers used by different animals. |  
**How can we change the properties of sound?**  
How can we make loud and soft sounds?  
How can we make low-pitched and high-pitched sounds?  
How does sound travel from the source to the receiver?  
How can we use sound to communicate over long distances? |
| **Inv. 3: Light and Shadows** |  
Students use flashlights, sunlight, and solid materials that block light to explore the phenomena of light and shadows. They create and change shadows and investigate how light interacts with objects that are transparent, translucent, and opaque. |  
**What is shadow?**  
What makes a shadow?  
How can we use the Sun to create shadows?  
What happens when different materials block light? |
| **Inv. 4: Light and Mirrors** |  
Students explore the phenomenon of light travel by positioning mirrors to reflect images so they can see their own eyes and view objects behind them. They investigate how to use one and two mirrors to direct light to different locations. They experience the phenomenon that objects can be seen only when light is available. They explore the shapes and location of eyes on different animals. Students read about devices that use light to communicate information. |  
**How does light travel and change direction?**  
How do animals (including humans) use light?  
How can we redirect a light beam?  
What can we see with a mirror?  
What can be seen with no light?  
How can we communicate with light? |
### Module Matrix

<table>
<thead>
<tr>
<th>Content Related to Disciplinary Core Ideas</th>
<th>Reading/Technology</th>
<th>Assessment</th>
</tr>
</thead>
</table>
| - Vibration is a rapid back-and-forth motion.  
- Vibrating objects make sound; a sound always comes from a vibrating source.  
- Sounds can make objects vibrate.  
- Sound sources can be natural or human-made.  
- Ears are one kind of sound receiver.  
- Sounds can convey information. | **Science Resources Book**  
“Vibrations and Sound”  
“Listen to This”  
**Online Activity**  
“Sorting Sounds” | **Embedded Assessment**  
Performance assessment  
Science notebook entry  
**Benchmark Assessment**  
Investigation 1 I-Check  
**NGSS Performance Expectation**  
1-PS4-1 |
| - Light sources are objects or systems that radiate, such as lamps, flashlights, candles, and the Sun.  
- Light travels from a source in all directions.  
- Shadows are the dark areas that result when light is blocked.  
- Some materials block light entirely or partially; other materials allow light to travel through.  
- The length and direction of a shadow depends on the position of the light source. | **Science Resources Book**  
“Playing in the Light”  
**Videos**  
Light and Shadows  
All about Light  
My Shadow | **Embedded Assessment**  
Science notebook entries  
Performance assessment  
**Benchmark Assessment**  
Investigation 2 I-Check  
**NGSS Performance Expectation**  
1-PS4-1; 1-PS4-4  
K–2 ETS1-1; K–2 ETS1-2;  
K–2 ETS1-3 |
| - Light travels in straight lines. A mirror can be used to redirect light.  
- Mirror images are the result of light reflected from a surface. An image produced by something that reflects, such as a mirror, is always reversed.  
- Light is necessary for animals to see.  
- Animal eyes are not all the same.  
- Light can be used to communicate over long distances. | **Science Resources Book**  
“Reflections”  
“Seeing the Light”  
“Communicating with Light”  
**Video**  
Light and Darkness | **Embedded Assessment**  
Performance assessments  
Science notebook entries  
**Benchmark Assessment**  
Investigation 4 I-Check  
**NGSS Performance Expectation**  
1-PS4-2; 1-PS4-3; 1-PS4-4  
K–2 ETS1-1; K–2 ETS1-2;  
K–2 ETS1-3 |
SOUND AND LIGHT — Overview

FOSS COMPONENTS

Teacher Toolkit for Each Module

The FOSS Next Generation Program has three modules for grade 1—Sound and Light, Air and Weather, and Plants and Animals.

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 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 are also in the bound *Teacher Resources* book.

- Foss Program Goals
- Planning Guide—Grade 1
- Science and Engineering Practices—Grade 1
- Crosscutting Concepts—Grade 1
- Sense-Making Discussions for Three-Dimensional Learning—Grade 1
- Access and Equity
- Science Notebooks in Grades K–2
- Science-Centered Language Development
- Foss and Common Core Ela—Grade 1
- Foss and Common Core Math—Grade 1
- Taking Foss Outdoors
- Science Notebook Masters
- Teacher Masters
- Assessment Masters

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

The Foss Program provides the materials needed for the investigations 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.
**FOSS Science Resources Books**

FOSS Science Resources: Sound and Light is a book of original readings developed to accompany this module. The readings are referred to as articles in Investigations Guide. Students read the articles in the book as they progress through the module. The articles cover specific concepts, usually after the concepts have been introduced in the active investigation.

The articles in FOSS Science Resources and the discussion questions provided in Investigations Guide help students make connections to the science concepts introduced and explored during the active investigations. Concept development is most effective when students are allowed to experience organisms, objects, and phenomena firsthand before engaging the concepts in text. The text and illustrations help make connections between what students experience concretely and the ideas that explain their observations.

**NOTE**

FOSS Science Resources: Sound and Light is also provided as a big book in the equipment kit.

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**Playing in the Light**

This boy has a shadow.
Look at the shadow.
Does it show what the boy is doing?

What do you see in this picture?
A girl on a swing?
Where is the girl?
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 Investigations 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 online activities.

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.

NOTE

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

NOTE

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

FOSS is designed around active investigation that provides engagement with science concepts and science and engineering practices. Surrounding and supporting those firsthand 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 makes a shadow?) 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 different materials block light. 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 in their science notebooks a summary of their learning as well as 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. These can be used as scaffolds until students are ready to write independently. Student work is entered partly in spaces provided on the notebook sheets and partly on adjacent blank sheets in the composition book. Full-sized duplication masters are available on FOSSweb. Look to the chapter in Teacher Resources called Science Notebooks in Grades K–2 for more details on how to use 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 using 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 Common Core ELA in Teacher Resources shows how FOSS provides opportunities to develop and exercise the Common Core State Standards for ELA practices through science. A detailed table identifies these opportunities in the three FOSS modules for the first 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 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 an active investigation.

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 look at students’ engagement in science and engineering practices or their recognition of crosscutting concepts. 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 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.

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 for grades 1–2 are delivered after each investigation (I-Checks). These assessments can also be used to monitor and adjust instruction based on student understandings.
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.

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

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

FOSS INVESTIGATION ORGANIZATION

SCIENCE AND ENGINEERING PRACTICES
Planning and carrying out investigations

DISCIPLINARY CORE IDEAS
ESS4.B: Electromagnetic radiation

CROSSCUTTING CONCEPTS
Cause and effect

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

Part of being a scientist is learning how to work collaboratively with others. However, students in primary grades are usually most comfortable working as individuals with materials. The abilities to share, take turns, and learn by contributing to a group goal are developing but are not reliable as learning strategies all the time. Because of this egocentrism and the need for many students to control materials or dominate actions, the FOSS kit includes a lot of materials. To effectively manage students and materials, here are some suggestions.

Whole-Class Discussions

Introducing and wrapping up the center activities require you to work for brief periods with the whole class. FOSS suggests for these introductions and wrap-ups that you gather the class at the rug or other location in the classroom where students can sit comfortably in a large group.

At the beginning of the year, explain and discuss norms for sense-making discussions. You might start by together making a class poster with visuals to represent what it looks like, sounds like, and feels like when everyone is working and learning together. Model discussion protocols that give all students opportunities to speak and listen, such as think-pair-share. Review the norms before sense-making discussions, and leave time for reflecting on how well the group adhered to the norms. More strategies for developing oral discourse skills can be found in Sense-Making Discussions for Three-Dimensional Learning and the Science-Centered Language Development chapters in Teacher Resources on FOSSweb.

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 first-grade students learn to 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, to share their ideas, and ask questions. Remind students that everyone in the classroom is a learner, and that learning happens when we try to figure things out. Here are a few ways to help students develop a growth mindset 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 reported their observations, the relevancy of their questions, how well they connected or applied new concepts, and their use of new vocabulary, etc. Also, try to provide feedback that encourages students to continue to improve their learning and exploring, e.g., Is there another way you could try? Have you thought about _____? Why do you think _____?

• **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. For example, “Did you all notice how Carla changed her idea about _____?”

Establishing a classroom culture that supports three-dimensional teaching and learning centers on collaboration. Helping students to work together in pairs and small groups, and to adhere to norms for discussions, are ways 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.

**Small-Group Centers**

Some of the observations and investigations in this module can be conducted with small groups at a learning center. For example, working with closed cardboard boxes to find out what you can see with no light in Investigation 4, Part 3, could be conducted at a center. Limit the number of students at the center to six to ten at one time. When possible, each student will have his or her own equipment to work with. In some cases, students will have to share materials and equipment and make observations together. As one group at a time is working at the center on a FOSS activity, other students will be doing something else. Over the course of an hour or more, plan to rotate all students through the center, or allow the center to be a free-choice station.
When You Don’t Have Adult Helpers

Some parts of investigations work better when there is an aide or a student’s family member available to assist groups with the activity and to encourage discussion and vocabulary development. We realize that there are many primary classrooms in which the teacher is the only adult present. You might invite upper-elementary students to visit your class to help with the activities. Remind older students to be guides and to let primary students do the activities themselves.

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. (Photo equipment cards are available in English and Spanish formats.)

For whole-class activities, 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.
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: FOSS Science Safety for classroom use and FOSS 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, 8:00 a.m.–5:00 p.m. ET).

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.
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. Do not taste anything unless your teacher tells you to do so.
- 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.
- Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
- Always protect your eyes. Wear safety goggles when necessary.
- Tell your teacher if you wear contact lenses.
- Always wash your hands with soap and warm water after handling chemicals, plants, or animals.
- Never mix any chemicals unless your teacher tells you to do so.
- Report all spills, accidents, and injuries to your teacher.
- Treat animals with respect, caution, and consideration.
- Clean up your work space after each investigation.
- Act responsibly during all science activities.

Outdoor 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. Let your teacher know if you have never been stung by a bee.
- 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. When you hear the “freeze” signal, stop and listen to your teacher.
- Never look directly at the Sun or at the sunlight being reflected off a shiny object.
- 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.

Sound and Light Module—FOSS Next Generation
SCHEDULING THE MODULE

On the next page 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 8 weeks be devoted to this module.

Active-investigation (A) sessions include hands-on work with materials and tools, 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.

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

I-Checks are short summative assessments at the end of each investigation. See the Assessment chapter for more details.
### Scheduling the Module

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<th>Week</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
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<td>R/W</td>
<td>START Inv. 1 Part 2</td>
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<td>A/W</td>
</tr>
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<td>R/W</td>
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#### NOTE

The Getting Ready section for each part of an investigation helps you prepare. It provides information on scheduling the activities and introduces the tools and techniques used in the activity. 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