INTRODUCTION

The Animals Two by Two Module provides early-childhood students with close and personal interaction with some common land and water animals. Appropriate classroom habitats are established, and students learn to care for the animals. In four investigations, animals are studied in pairs. Students observe and care for one animal over time, and then they are introduced to another animal similar to the first but with differences in structure and behavior. The firsthand experiences are enriched with close-up photos of animals, some related to animals that students have observed in class and some to animals that are new. This process enhances observation, communication, and comparison. In this module, students will

- Observe and describe the structures of a variety of common animals—fish, birds, snails, earthworms, and isopods.
- Compare structures and behaviors of different pairs of animals.
- Observe interactions of animals with their surroundings.
- Describe properties of objects, compare them, and sort them by properties.
- Communicate observations and comparisons orally and through words and drawings.
- Handle animals carefully, and participate in the care and feeding of classroom animals.

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### Module Summary

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<th>Module</th>
<th>Overview</th>
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<tbody>
<tr>
<td>Inv. 1: Goldfish and Guppies</td>
<td>Students observe the structures and behaviors of goldfish. They feed the fish and enrich the environment in which the fish live. They compare the structures and behaviors of the goldfish to those of other fish, guppies. Students compare photos of fish and read about fish. They go bird watching in the schoolyard and compare features and behaviors of birds.</td>
</tr>
<tr>
<td>Inv. 2: Water and Land Snails</td>
<td>Students observe the structures and behaviors of two kinds of water snails. Students work with a variety of seashells, discussing similarities and differences in their size, shape, color, and texture. Students match shell pairs, make designs, and create patterns. Students explore the schoolyard to find local land snails and compare their structures and behaviors to water snails.</td>
</tr>
<tr>
<td>Inv. 3: Big and Little Worms</td>
<td>Students dig for redworms, rinse them off, and look at their structures. They study their behavior. They construct worm jars and provide for the needs of the composting worms. Students observe how the worms change the plant material into soil. They compare the redworms to night crawlers, which are much larger. Students compare photos and read about worms and their activities in soil.</td>
</tr>
<tr>
<td>Inv. 4: Pill Bugs and Sow Bugs</td>
<td>Students observe structures of two kinds of isopods. They learn to identify which are pill bugs and which are sow bugs. They hold isopod races. Students make a terrarium in which all the land animals live together. They compare photos and read about isopods. They read about and compare illustrations of a variety of animals and discuss the difference between living and nonliving things.</td>
</tr>
</tbody>
</table>

### Focus Questions

<table>
<thead>
<tr>
<th>Module</th>
<th>Focus Questions</th>
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</thead>
</table>
| Inv. 1: Goldfish and Guppies | What are the parts of a goldfish?  
What do goldfish need to live?  
What do goldfish do?  
How are guppies and goldfish different?  
How are they the same?  
What birds visit our schoolyard? |
| Inv. 2: Water and Land Snails | What are the parts of a water snail?  
How can shells be grouped?  
What do land snails do? |
| Inv. 3: Big and Little Worms | What are the parts of a redworm?  
What do redworms need to live?  
How are redworms and night crawlers different?  
How are they the same? |
| Inv. 4: Pill Bugs and Sow Bugs | What are isopods?  
How are pill bugs and sow bugs different?  
How are they the same?  
How do isopods move?  
What do animals need to live? |
<table>
<thead>
<tr>
<th>Content</th>
<th>Reading</th>
<th>Assessment</th>
</tr>
</thead>
</table>
| Fish are animals and have basic needs.  
Fish have structures that help them live and grow.  
Different kinds of fish have similar but different structures and behaviors.  
Birds are animals that have basic needs.  
Different kinds of birds have similar but different structures and behaviors. |
| **Science Resources Book**  
"Fish Same and Different"  
"Fish Live in Many Places"  
"Birds Outdoors" | **Embedded Assessment**  
Teacher observation |
| Different kinds of snails have some structures and behaviors that are the same and some that are different.  
Snails are animals and have basic needs—water, air, food, and space with shelter.  
There is great diversity among snails.  
Shells differ in size, shape, pattern, and texture.  
Snails have senses. |
| **Science Resources Book**  
"Water and Land Snails"  
**Media**  
Seashore Surprises  
Is This a House for Hermit Crab? | **Embedded Assessment**  
Teacher observation |
| Worms are animals and have basic needs.  
Worms have identifiable structures.  
Different kinds of worms have similar structures and behaviors; they also have differences (size, color).  
Worm behavior is influenced by conditions in the environment.  
Worms change plant material into soil. |
| **Science Resources Book**  
"Worms in Soil" | **Embedded Assessment**  
Teacher observation |
| Isopods are animals and have basic needs—water, air, food, and space with shelter.  
Different kinds of isopods have some structures and behaviors that are the same and some that are different.  
There is great diversity among isopods.  
Isopod behavior is influenced by conditions in the environment. |
| **Science Resources Book**  
"Isopods"  
"Animals All around Us"  
"Living and Nonliving"  
**Media**  
Animals Two by Two | **Embedded Assessment**  
Teacher observation |
FOSS CONCEPTUAL FRAMEWORK

In the last half decade, teaching and learning research has focused on learning progressions. The idea behind a learning progression is that core ideas in science are complex and wide-reaching, requiring years to develop fully—ideas such as the structure of matter or the relationship between the structure and function of organisms. From the age of awareness throughout life, matter and organisms are important to us. There are things students can and should understand about these core ideas in primary school years, and progressively more complex and sophisticated things they should know as they gain experience and develop cognitive abilities. When we as educators can determine those logical progressions, we can develop meaningful and effective curricula for students.

FOSS has elaborated learning progressions for core ideas in science for kindergarten through grade 8. Developing a learning progression involves identifying successively more sophisticated ways of thinking about a core idea over multiple years. “If mastery of a core idea in a science discipline is the ultimate educational destination, then well-designed learning progressions provide a map of the routes that can be taken to reach that destination” (National Research Council, *A Framework for K–12 Science Education*, 2011).

The FOSS modules are organized into three domains: physical science, earth science, and life science. Each domain is divided into two strands, as shown in the table below for the FOSS Elementary Program. Each strand represents a core idea in science and has a conceptual framework.

- Physical Science: matter; energy and change
- Earth Science: dynamic atmosphere; rocks and landforms
- Life Science: structure and function; complex systems

The sequence in each strand relates to the core ideas described in the national framework. Modules at the bottom of the table form the foundation in the primary grades. The core ideas develop in complexity as you proceed up the columns.

Information about the FOSS learning progression appears in the conceptual framework (page 7), which shows the structure of scientific knowledge taught and assessed in this module, and the content sequence (pages 8–9), a graphic and narrative description that puts this single module into a K–8 strand progression.

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**TEACHING NOTE**

FOSS has conceptual structure at the module and strand levels. The concepts are carefully selected and organized in a sequence that makes sense to students when presented as intended.
In addition to the science content development, every module provides opportunities for students to engage in and understand the importance of scientific practices, and many modules explore issues related to engineering practices and the use of natural resources.

**Asking questions and defining problems**
- Ask questions about objects, organisms, systems, and events in the natural and human-made world (science).
- Ask questions to define and clarify a problem, determine criteria for solutions, and identify constraints (engineering).

**Planning and carrying out investigations**
- Plan and conduct investigations in the laboratory and in the field to gather appropriate data (describe procedures, determine observations to record, decide which variables to control) or to gather data essential for specifying and testing engineering designs.

**Analyzing and interpreting data**
- Use a range of media (numbers, words, tables, graphs, images, diagrams, equations) to represent and organize observations (data) in order to identify significant features and patterns.

**Developing and using models**
- Use models to help develop explanations, make predictions, and analyze existing systems, and recognize strengths and limitations of proposed solutions to problems.

**Using mathematics and computational thinking**
- Use mathematics and computation to represent physical variables and their relationships and to draw conclusions.

**Constructing explanations and designing solutions**
- Construct logical explanations of phenomena, or propose solutions that incorporate current understanding or a model that represents it and is consistent with available evidence.

**Engaging in argument from evidence**
- Defend explanations, develop evidence based on data, examine one’s own understanding in light of the evidence offered by others, and challenge peers while searching for explanations.

**Obtaining, evaluating, and communicating information**
- Communicate ideas and the results of inquiry—oral ly and in writing—with tables, diagrams, graphs, and equations, in collaboration with peers.
BACKGROUND FOR THE CONCEPTUAL FRAMEWORK in Animals Two by Two

The year in kindergarten might be the first time many children are introduced to animals other than the familiar neighborhood animals that humans have invited into their homes as pets. The typical kindergartner’s concept of animal is narrow, embracing for the most part a selection of mammals. When asked to recall the names of a few animals, kindergartners will provide lists that read like farm and zoo inventories. Cats, dogs, bears, birds, and the parade of other animals are not all animals to early-childhood students—they are cats, dogs, bears, and birds, each in a category of its own. The conceptual organization used by kindergartners does not yet recognize the superordinate set called animals that includes all the members in the kingdom of animals. This module will start expanding students’ concept of animal by providing experiences with a number of animals that look and act quite unlike the barnyard model.

Life has proliferated on our planet for the last 3.5 billion years. There were no animals for most of that time—bacteria held a monopoly for the first 2 billion years. Animals probably emerged on the scene about 700 million years ago in forms similar to present-day sponges and jellyfish. An organism in the animal kingdom is multicellular and must eat to survive. Unlike members of the plant kingdom, animals cannot make their own food by photosynthesis (or a related process), so they must eat other organisms to get the energy needed to sustain life.

Kingdom Animalia has more members than any of the other kingdoms (Monera, Protista, Plantae, and Fungi). By some estimates 10 million different kinds of animals are living today, but many experts agree that the actual number could be many times greater. Better estimates are available for the number of animals that have backbones—mammals, fish, birds, reptiles, and amphibians. There are about 42,500 kinds of vertebrates. The great multitudes that make up the rest of the animal kingdom are known collectively as invertebrates, including the mollusks (clams, snails), crustaceans (crabs, shrimps, isopods), annelids (worms), and insects. Far and away the most populous class of animals is Insecta, with more members than all the other described animals combined.

In this module, students observe firsthand and describe aquatic vertebrates (goldfish and guppies), mollusks (water snails and land snails), annelids (redworms and night crawlers), and crustaceans...
Animals Two by Two

(isopods). Through photos, they are introduced to a variety of birds. Obvious in their absence are the insects, which because of their rearing needs we saved for another grade, with a whole module devoted to these diverse and interesting animals.

There are many wonderful children’s fiction books that portray animals and plants with human characteristics—plants that can walk and talk, and animals that talk and wear human clothes. These fanciful stories, whether serious or humorous, capture the imagination of children. But it is important to help young students distinguish fact from fantasy.

Through their firsthand experiences in the FOSS modules Trees and Weather and Animals Two by Two, kindergarten students will develop a scientific understanding about the structures and behaviors of real plants and animals. Students will become good observers of organisms, and they will be able to communicate those observations through words and drawings. This scientific understanding of animals and plants will help students appreciate imaginary animals and plants they read about in fictional stories.

After reading a fictional story that gives plants or animals attributes they do not really have, take the time to ask students what was real and what was imaginary in the story. Have students compare their own firsthand experiences with plants and animals to those in the story.

CONCEPTUAL FRAMEWORK
Life Science, Focus on Structure and Function: Animals Two by Two

Structures and Function
Concept A All living things need food, water, a way to dispose of waste, and an environment in which they can live.
- Animals have identifiable structures and behaviors.
Concept B Reproduction is essential to the continued existence of every kind of organism. Organisms have diverse life cycles.
- Adult animals and plants can have offspring.
Concept C Animals detect, process, and use information about their environment to survive.

Complex Systems
Concept A Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with nonliving factors.
- A habitat is a place where animals live and their needs are met. There are many different kinds of habitats.
Concept C Heredity involves passing information from one generation to the next and introducing variation of traits between individuals in a population.
- Individuals of the same kind are recognizable as similar but can also vary in many ways.
Concept D Biological evolution, the process by which all living things have evolved over many generations from common ancestors, explains both the unity and diversity of species.
- Living things can survive only where their needs are met.
Life Science Content Sequence

This table shows the FOSS modules that inform the structure and function and complex systems strands. The supporting elements in these modules (somewhat abbreviated) are listed. The elements for the Animals Two by Two Module are expanded to show how they fit into the sequence.

<table>
<thead>
<tr>
<th>Module or course</th>
<th>Structure and Function</th>
<th>Complex Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Brain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Populations and Ecosystems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diversity of Life</td>
<td>- All living things are made of cells (unicellular or multicellular). Special structures within cells are responsible for various functions.</td>
<td>- Adaptations are structures or behaviors of organisms that enhance their chances to survive and reproduce in their environment.</td>
</tr>
<tr>
<td></td>
<td>- Cells have the same needs and perform the same functions as more complex organisms.</td>
<td>- Biodiversity is the wide range of existing life-forms that have adapted to the variety of conditions on Earth, from terrestrial to marine ecosystems.</td>
</tr>
<tr>
<td></td>
<td>- All living things need food, water, a way to dispose of waste, and an environment in which they can live (macro and microlevel).</td>
<td></td>
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<tr>
<td></td>
<td>- Plants reproduce in a variety ways.</td>
<td></td>
</tr>
<tr>
<td>Living Systems</td>
<td>- Food provides animals with the materials they need for body repair and growth and is digested to release the energy they need.</td>
<td>- Organisms obtain gases, water, and minerals from the environment and release waste matter back into the environment.</td>
</tr>
<tr>
<td></td>
<td>- Reproduction is essential to the continued existence of every kind of organism.</td>
<td>- Matter cycles between air and soil, and among plants, animals, and microbes as these organisms live and die.</td>
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<tr>
<td></td>
<td>- Humans and other animals have systems made up of organs that are specialized for particular body functions.</td>
<td>- Organisms are related in food webs.</td>
</tr>
<tr>
<td></td>
<td>- Animals detect, process, and use information about their environment to survive.</td>
<td>- Some organisms, such as fungi and bacteria, break down dead organisms, operating as decomposers.</td>
</tr>
<tr>
<td>Environments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structures of Life</td>
<td>- A seed is a living organism.</td>
<td>- Organisms are related in food chains.</td>
</tr>
<tr>
<td></td>
<td>- Plants and animals have structures that function in growth and survival.</td>
<td>- Different organisms can live in different environments; adaptations allow them to survive in that environment.</td>
</tr>
<tr>
<td></td>
<td>- Reproduction is essential to the continued existence of every kind of organism.</td>
<td>- Changes in an organism’s habitat are sometimes beneficial, sometimes harmful.</td>
</tr>
<tr>
<td></td>
<td>- Organisms have diverse life cycles.</td>
<td>- Many characteristics of organisms are inherited from parents; other characteristics result from the environment.</td>
</tr>
<tr>
<td></td>
<td>- Behavior of animals is influenced by internal and external cues.</td>
<td>- A skeleton is a system of bones.</td>
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<tr>
<td></td>
<td>- Bones have several functions: support, protection, and movement.</td>
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<tr>
<td>Insects and Plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plants and Animals</td>
<td>- Plants and animals have structures that function in growth and survival.</td>
<td>- Plants make their own food. Plants depend on air, water, nutrients, and light to grow.</td>
</tr>
<tr>
<td></td>
<td>- Reproduction is essential to the continued existence of every kind of organism.</td>
<td>- Plants are very much, but not exactly, like their parent.</td>
</tr>
<tr>
<td></td>
<td>- Plants and animals grow and change and have predictable stages.</td>
<td>- There are many kinds of habitats.</td>
</tr>
<tr>
<td></td>
<td>- Adult plants and animals can have offspring.</td>
<td>- Living things can survive only where their needs are met.</td>
</tr>
<tr>
<td>Animals Two by Two</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trees and Weather</td>
<td>- Trees are living plants and have structures.</td>
<td>- Individuals of the same kind (plants or animals) are recognizable as similar but can also vary in many ways.</td>
</tr>
<tr>
<td></td>
<td>- Trees go through predictable stages.</td>
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</tr>
</tbody>
</table>
Animals have identifiable structures and behaviors.
Animals have basic needs. Land animals need air, water, food, and space with shelter. Water animals need the appropriate kind of water, oxygen from the water, food, and space with shelter.
Adult animals and plants can have offspring.

Individual animals of the same kind are recognizable as similar but can also vary in many ways.
A habitat is a place where animals live and their needs are met. There are many different kinds of habitats.
Living things can survive only where their needs are met.
The **Animals Two by Two Module** aligns with the NRC *Framework*. The module addresses these K–2 grade band endpoints described for core ideas from the national framework for life science and for engineering, technology, and the application of science.

### Life Sciences

**Core idea LS1: From Molecules to Organisms: Structures and Processes—How do organisms live, grow, respond to their environment, and reproduce?**

- **LS1.A**: *How do the structures of organisms enable life’s functions?*  
  [All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants.]

- **LS1.B**: *How do organisms grow and develop?*  
  [Plants and animals have predictable characteristics at different stages of development. Plants and animals grow and change. Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring survive.]

- **LS1.C**: *How do organisms obtain and use the matter and energy they need to live and grow?*  
  [All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.]

- **LS1.D**: *How do organisms detect, process, and use information about the environment?*  
  [Animals have body parts that capture and convey different kinds of information needed for growth and survival—for example, eyes for light, ears for sounds, and skin for temperature or touch. Animals respond to these inputs with behaviors that help them survive (e.g., they find food, run from a predator). Plants also respond to some external inputs (e.g., they turn leaves toward the Sun).]
Core idea LS2: Ecosystems: Interactions, Energy, and Dynamics—How and why do organisms interact with their environment, and what are the effects of these interactions?

• LS2.C: What happens to ecosystems when the environment changes? [The places where plants and animals live often change, sometimes slowly and sometimes rapidly. When animals and plants get too hot or too cold, they may die. If they cannot find enough food, water, or air, they may die.]

Core idea LS3: Heredity: Inheritance and Variation of Traits—How are characteristics of one generation passed to the next? How can individuals of the same species and even siblings have different characteristics?

• LS3.A: How are the characteristics of one generation related to the previous generation? [Organisms have characteristics that can be similar or different. Young animals are very much, but not exactly, like their parents and also resemble other animals of the same kind. Plants also are very much, but not exactly, like their parents and resemble other plants of the same kind.]

Core idea LS4: Biological Evolution: Unity and Diversity—How can there be so many similarities among organisms yet so many different kinds of plants, animals, and microorganisms? How does biodiversity affect humans?

• LS4.D: What is biodiversity, how do humans affect it, and how does it affect humans? [There are many different kinds of living things in any area, and they exist in different places on land and in water.]
FOSS COMPONENTS

Teacher Toolkit

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
- Materials
- Investigations (four in this module)
- Assessment

Teacher Resources. This collection of resources contains these chapters.

- FOSS Introduction
- Science Notebooks in Grades K–2
- Science-Centered Language Development
- Taking FOSS Outdoors
- FOSSweb and Technology
- Science Notebook Masters (for grades 1–6)
- Teacher Masters
- Assessment Masters

The chapters in Teacher Resources and the Spanish duplication masters can also be found on FOSSweb (www.FOSSweb.com) and on CDs included in the Teacher Toolkit.

FOSS Science Resources. One copy of the student book of readings is included in the Teacher Toolkit.

Equipment Kit

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


**FOSS Components**

**FOSS Science Resources Books**

*FOSS Science Resources: Animals Two by Two* 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 a specific concept, usually after that concept has been introduced in an active investigation.

The articles in *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 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.

**FOSSweb and Technology**

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

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

**Ongoing Professional Development**

The Lawrence Hall of Science and Delta Education are committed to supporting science educators with unrivaled teacher support, high-quality implementation, and continuous staff-development opportunities and resources. FOSS has a strong network of consultants who have rich and experienced backgrounds in diverse educational settings using FOSS. Find out about professional-development opportunities on FOSSweb.

*Animals Two by Two Module*
FOSS INSTRUCTIONAL DESIGN

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

- Active investigation, including outdoor experiences
- Recording in science notebooks to answer the focus question
- Reading in FOSS Science Resources
- Assessment to monitor progress and motivate student reflection on learning

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

FOSS Investigation Organization

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

Investigation-specific scientific background information for the teacher is presented in each investigation chapter. The content discussion is divided into sections, each of which relates directly to one of the focus questions. This section ends with information about teaching and learning and a conceptual-flow diagram for the content.

The Getting Ready and Guiding the Investigation sections have several features that are flagged or presented 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.

Teaching notes appear in blue boxes in the sidebars. These notes constitute a second voice in the curriculum—an educative element. The first (traditional) voice is the message you deliver to students. It supports your work teaching students at all levels, from management to inquiry. 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.

FOCUS QUESTION

What are the parts of a goldfish?

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 **safety** icon alerts you to a potential safety issue. It could relate to the use of a chemical substance, such as salt, requiring safety goggles, or the possibility of a student allergic reaction when students use latex, legumes, or wheat.

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 new vocabulary should also be entered on the word wall (or pocket chart). A complete list of the scientific vocabulary used in each investigation appears in the sidebar on the last page of the Background for the Teacher section.

The **vocabulary** icon indicates where students should review recently introduced vocabulary, often just before they will be answering the focus question or preparing for benchmark assessment.

The **recording** icon points out where students should make a science-notebook entry. Students record on prepared notebook sheets or, increasingly, on pages in their science notebooks.

The **reading** icon signals when the class should read a specific article in *FOSS Science Resources*, preferably during a reading period.

The **assessment** icon appears when there is an opportunity to assess student progress, by using embedded assessments. Some of the embedded-assessment methods for grades K–2 include observation of students engaged in scientific practices and review of a notebook entry (drawing or text).

The **outdoor** icon signals when to move the science learning experience into the schoolyard. It also helps you plan for selecting and preparing an outdoor site for a student activity.

The **engineering** icon indicates opportunities for addressing engineering practices—applying and using scientific knowledge. These opportunities include developing a solution to a problem, constructing and evaluating models, and using systems thinking.

The **EL note** in the sidebar provides a specific strategy to assist English learners in developing science concepts. A discussion of strategies is in the Science-Centered Language Development chapter.

To help with pacing, you will see icons for **breakpoints**. Some breakpoints are essential, and others are optional.
Active Investigation

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

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

Context: questioning and planning. Active investigation requires focus. The context of an inquiry can be established with a focus question or challenge from you or, in some cases, from students. (What do goldfish do?) 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 guppies and goldfish are different. 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 and the readings to lead students to a comprehensive understanding of concepts. Through the investigations, 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 that 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 existing knowledge. Students share their explanations for phenomena, using evidence generated during the investigation to support their ideas. Students conclude the active investigation by writing a summary of their learning in their science notebooks 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 elements of the assessment system.
Reading in FOSS Science Resources

The FOSS Science Resources books emphasize expository articles and biographical sketches. FOSS suggests that the reading be completed during language-arts time. 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.

Assessing Progress for Kindergarten

Assessment and teaching must be woven together to provide the greatest benefit to both the student and the teacher. Assessing young students is a process of planning what to assess, and observing, questioning, and recording information about student learning for future reference. Observing students as they engage in the activity and as they share notebook entries (drawings and words) reveals their thinking and problem-solving abilities. Questioning probes for understanding. Both observing and questioning will give you information about what individual students can and can’t do, and what they know or don’t know. This information allows you to plan your instruction thoughtfully. For example, if you find students need more experience comparing isopods, you can provide more time at a center for sorting and recording observations in their notebooks.

Use the techniques that work for you and your students and that fit with the overall kindergarten curriculum goals. The most detailed and reliable picture of students’ growth emerges from information gathered by a variety of assessment strategies.

FOSS embedded assessments for kindergarten allow you and your students to monitor learning on a daily basis as you progress through the Animals Two by Two Module. You will find suggestions for what to assess in the Getting Ready section of each part of each investigation. For example, here is the Getting Ready step for Part 1 of the first investigation.
15. Plan assessment for Part 1
There are six objectives that can be assessed at any time during any part of this investigation.

What to Look For

• Students ask questions.
• Students use their senses to observe living things.
• Students show respect for living things.
• Students record observations.
• Students communicate observations orally, in writing, and in drawings.
• Students use new vocabulary.

Here is a specific content objective for this part.

• Animals have structures to meet their needs.

Focus on a few students each session. Record the date and a + or − on Assessment Checklist.

Make copies of Assessment Checklist, attach them to a clipboard, and carry them with you when students are engaged in the investigations. Record your observations as you interact with students, or take a few minutes after class to reflect on the lesson.
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.

Most investigations include 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 who have behavior issues in the classroom but who become 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 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.

FOSS is very enthusiastic about this dimension of the program and looks forward to hearing about your experience using the schoolyard as a logical extension of your classroom.
Science-Centered Language Development

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. We identify best practices in language-arts instruction that support science learning and examine how learning science content and engaging in scientific practices support 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 and strategies support conceptual development and scientific practices. For example, the skills and strategies used for enhancing reading comprehension, writing expository text, and exercising oral discourse are applied when students are recording their observations, making sense of science content, and communicating their ideas. Students’ use of language improves when they discuss (speak and listen, as in the Wrap-Up/Warm-Up activities), write, and read about the concepts explored in each investigation.

There are many ways to integrate language into science investigations. 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. The last section covers language-development strategies specifically for English learners.

Embedded even deeper in the FOSS pedagogical practice is a bolder philosophical stance. Because language arts commands the greatest amount of the instructional day’s time, FOSS has devoted a lot of creative energy to defining and exploring the relationship between science learning and the development of language-arts skills. FOSS elucidates its position in the Science-Centered Language Development chapter.
FOSSWEB AND TECHNOLOGY

FOSS is committed to providing a rich, accessible technology experience for all FOSS users. FOSSweb is the Internet access to FOSS digital resources. It provides enrichment for students and support for teachers, administrators, and families who are actively involved in implementing and enjoying FOSS materials. Here are brief descriptions of selected resources to help you get started with FOSS technology.

Technology to Engage Students at School and at Home

Multimedia activities. The multimedia simulations and activities were designed to support students’ learning. They include virtual investigations and student tutorials that you can use to support students who have difficulties with the materials or who have been absent.

FOSS Science Resources. The student reading book is available as an audio book on FOSSweb, accessible at school or at home. In addition, as premium content, FOSS Science Resources is available as an eBook. The eBook supports a range of font sizes and can be projected for guided reading with the whole class as needed.

Home/school connection. Each module includes a letter to families, providing an overview of the goals and objectives of the module. Most investigations have a home/school activity that provides science experiences to connect the classroom experiences with students’ lives outside of school. These connections are available in print in the Teacher Resources binder and on FOSSweb.

Student media library. A variety of media enhance students’ learning. Formats include photos, videos, an audio version of each student book, and frequently asked science questions. These resources are also available to students when they log in with a student account.

Recommended books and websites. FOSS has reviewed print books and digital resources that are appropriate for students and prepared a list of these media resources.

Class pages. Teachers with a FOSSweb account can easily set up class pages with notes and assignments for each class. Students and families can then access this class information online.

NOTE
The FOSS digital resources are available online at FOSSweb. You can always access the most up-to-date technology information, including help and troubleshooting, on FOSSweb. See the FOSSweb and Technology chapter for a complete list of these resources.
Technology to Support Teachers

Teacher-preparation video. The video presents information to help you prepare for a module, including detailed investigation information, equipment setup and use, safety, and what students do and learn through each part of the investigation.

Science-notebook masters and teacher masters. All notebook masters (grades 1–6) and teacher masters used in the modules are available digitally on FOSSweb for downloading and for projection during class. These sheets are available in English and Spanish.

Focus questions. The focus questions for each investigation are formatted for classroom projection and for printing onto labels that students can glue into their science notebooks.

Equipment photo cards. The cards provide labeled photos of equipment supplied in each FOSS kit.

Materials Safety Data Sheets (MSDS). These sheets have information from materials manufacturers on handling and disposal of materials.

Teacher Resources chapters. FOSSweb provides PDF files of all chapters from Teacher Resources.

- FOSS Introduction
- Science Notebooks for Grades K–2
- Science-Centered Language Development
- Taking FOSS Outdoors
- FOSSweb and Technology

Streaming video. Some video clips are part of the instruction in the investigation, and others extend concepts presented in a module.

Resources by investigation. This digital listing provides online links to notebook sheets, assessment and teacher masters, and multimedia for each investigation of a module, for projection in the classroom.

Interactive-whiteboard resources. You can use these slide shows and other resources with an interactive whiteboard.

Investigations eGuide. The eGuide is the complete FOSS Investigations Guide component of the Teacher Toolkit in an electronic web-based format, allowing access from any Internet-enabled computer.

NOTE
The Spanish masters are available only on FOSSweb and on one of the CDs provided in the Teacher Toolkit.
UNIVERSAL DESIGN FOR LEARNING

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

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

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


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

English Learners

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

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

**Differentiated Instruction**

FOSS instruction allows students to express their understanding through a variety of modalities. Each student has multiple opportunities to demonstrate his or her strengths and needs. The challenge is then to provide appropriate follow-up experiences for each student. For some students, appropriate experience might mean more time with the active investigations. For other students, it might mean more experience building explanations of the science concepts orally or in writing or drawing. For some students, it might mean making vocabulary more explicit through new concrete experiences or through reading to students. For some students, it may be scaffolding their thinking through graphic organizers. For other students, it might be designing individual projects or small-group investigations. For some students, it might be more opportunities for experiencing science outside the classroom in more natural, outdoor environments.

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

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, FOSS offers some suggestions.

Small-Group Centers

Many of the kindergarten-level observations and investigations are conducted with small groups at a learning 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. Primary students are good at working together independently.

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.

Whole-Class Activities

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.

Guides for Adult Helpers

In Teacher Resources, you will find duplication masters for center instructions for some investigation parts. These sheets are intended as a quick reference for a family member or other adult who might be supervising the center. The sheets help that person keep the activity moving in a productive direction. The sheets can be laminated or slipped into a clear-plastic sheet protector for durability.
When You Don’t Have Adult Helpers

Some parts of investigations are designed for small groups, with an aide or a student’s family member available to guide 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. Here are some ways to manage in that situation.

- Invite upper-elementary students to visit your class to help with the activities. They should be able to read the center instructions and conduct the activities with students. Remind older students to be guides and to let primary students do the activities themselves.

- Introduce each part of the activity with the whole class. Set up the center as described in Investigations Guide, but let students work at the center by themselves. Discussion might not be as rich, but most of the centers can be done independently by students once they have been introduced to the process. Be a 1-minute manager, checking on the center from time to time, offering a few words of advice or direction.

When Students Are Absent

When a student is absent for an activity, 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.
SAFETY IN THE CLASSROOM AND OUTDOORS

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

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

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

Science Safety in the Classroom

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

1. Listen carefully to your teacher’s instructions. Follow all directions. Ask questions if you don’t know what to do.
2. Tell your teacher if you have any allergies.
3. Never put any materials in your mouth. Do not taste anything unless your teacher tells you to do so.
4. Never smell any unknown material. If your teacher tells you to smell something, wave your hand over the material to bring the smell toward your nose.
5. Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
6. Always protect your eyes. Wear safety goggles when necessary.
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.

Outdoor Safety

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. Let your teacher know if you have never been stung by a bee.
3. Never put any materials in your mouth.
4. Dress appropriately for the weather and the outdoor experience.
5. Stay within the designated study area and with your partner or group. When you receive the “freeze” signal, stop and listen to your teacher.
6. Never look directly at the Sun or at the sunlight being reflected off a shiny object.
7. Know if there are any skin-irritating plants in your schoolyard, and do not touch them. Most plants in the schoolyard are harmless.
8. Respect all living things. When looking under a stone or log, lift the side away from you so that any living thing can escape.
9. 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.
10. Never release any living thing into the environment unless you collected it there.
11. Always wash your hands with soap and warm water after handling chemicals, plants, or animals.
12. Always wash your hands with soap and warm water after handling chemicals, plants, animals, and soil.
13. Return to the classroom with all of the materials you brought outside.

Full Option Science System
SCHEDULING THE MODULE

The Getting Ready section for each part of the investigation helps you prepare. It provides information on scheduling the investigation and introduces the tools and techniques used in the investigation. The first item in the Getting Ready section gives an estimated amount of time the part should take. A general rule of thumb is to plan 10 minutes to introduce the investigation to the whole class, about 15-20 minutes at the center for each group, about 10 minutes to wrap up the activity with the whole class, and a few minutes to transition to the groups. Notebook sessions can be done with the whole class after everyone has participated in the center activities. All of the outdoor sessions are whole-class activities.

Below is a list of the investigations and parts and the format of the investigation (whole class, center, or a combination of the two).

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<th>PART</th>
<th>ORGANIZATION</th>
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<td>2. Caring for Goldfish</td>
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<tr>
<td></td>
<td>2. Shells</td>
<td>center/whole class</td>
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<tr>
<td></td>
<td>3. Land Snails</td>
<td>center/whole class</td>
</tr>
<tr>
<td>3. Big and Little Worms</td>
<td>1. The Structure of Redworms</td>
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<td>center/whole class</td>
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<td>4. Animals Living Together</td>
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NOTE
The investigations are numbered, and we suggest that they be conducted in order since the concepts build from investigation to investigation.
## FOSS K–8 SCOPE AND SEQUENCE

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**Overview**