FOSS

Developed at:

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

In FOSS, every phenomenon tells a story.

Phenomena Storylines in FOSS:

Lead students on a path of discovery.

In the era of NGSS, successful science teaching doesn't just task students to memorize rote facts—it challenges them to make sense of phenomena and solve problems. Storylines are central to this process of discovery.

A storyline takes shape in students' minds as they observe phenomena firsthand and make sense of what they find. These interactions lead them to ask questions, which lead them to the next step in a storyline. At every point, the students' own perspective is key; they know the overarching problem they're trying to solve and the role of each investigation in solving it.

FOSS® Next Generation, developed at UC Berkeley's Lawrence Hall of Science, puts storylines front and center for purposeful student learning. The power of each FOSS module and course is the carefully designed sequence of investigations, or storylines, that support students in figuring out elements of the phenomenon. Every FOSS module equips its teacher with an *Investigations Guide*, explicitly describing each module's storyline and supporting phenomenon-based teaching.

ANCHOR PHENOMENON 1
INVESTIGATIONS 1–3

After a hard rain, some students noticed a small pond next to a construction site. The water was brown right after the rain. The next day, they saw the pond water was clearer, and rocks and mud were on the bottom. Near the edge of the pond, the plants started to turn brown and die. **What caused the formation of the pond and how do you explain the changes observed to the water and plants?**

INTEGRATED NGSS DIMENSIONS

PS1.A: Structures and Properties of Matter

Cause and Effect; Scale, Proportion and Quantity

Developing and Using Models; Engaging in Argument From Evidence

NGSS PERFORMANCE EXPECTATIONS
5-PS1-1, 5-PS1-2, 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3

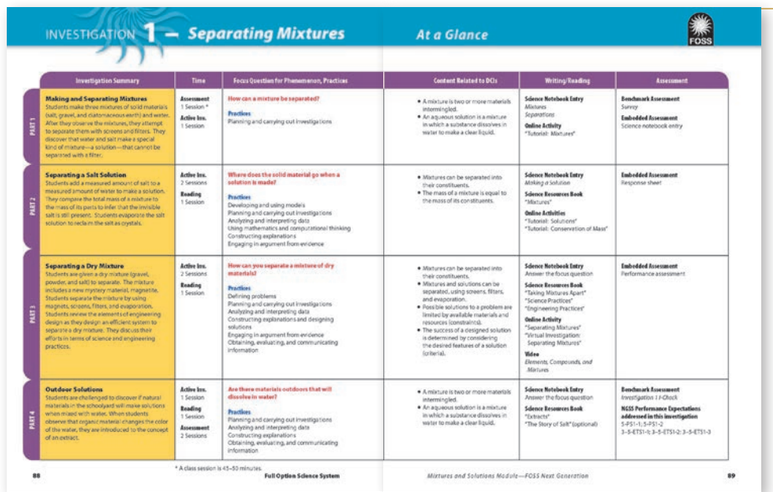
STORYLINE
Students investigate the changes to water and plants in a pond after a hard rain. They begin to construct an explanation of the changes in the water by mixing three solid materials (gravel, powder, and salt) into cups of water to observe three types of mixtures, revealing a phenomenon; dissolving. Next, they use measurement tools to gather evidence that the dissolved material (salt) is still present, but not visible (conservation of matter), and develop a model for the dissolved salt in water. Then, they use evaporation to separate salt from water. They apply what they learned about separating mixtures to construct an explanation of the changes to the water that has ponded. Finally, they analyze solutions and develop a model for concentration and use this model to determine impact of concentration of solutions on plants.

FOSS modules feature observable events that are appropriate to students' age and development levels. Anchor phenomena in each module help students make connections to aid their progress through a storyline.

All types of interaction for all types of students.

FOSS® offers students a multitude of ways to interact with local and relevant phenomena, allowing students to figure out and share their observations. FOSS storylines are tested in real classrooms to ensure that the sequence of activities is coherent, developmentally appropriate, and accessible to all students. Each storyline then offers students a variety of avenues to express that newfound understanding all along the way. Investigations in every FOSS module:

- Introduce an anchor phenomenon to students to help organize their learning, activate prior knowledge, and ask questions.
- Invite students to explore local and relevant phenomena.
- Incorporate opportunities to make sense of their learning of disciplinary core ideas related to the phenomenon, which is driven by Guiding and Focus questions.
- Call on students to use multiple modalities that will help them devise and revise models.
- Reflect on learning, with several different tools available to help monitor student progress.


INVESTIGATION 1 — Separating Mixtures — At a Glance

Investigation Summary	Time	Focus Question for Phenomenon, Practices	Content Related to DCIs	Writing/Reading	Assessment
PART 1 **Making and Separating Mixtures** Students make three mixtures of solid materials (salt, gravel, and diatomaceous earth) and water. After they observe the mixtures, they attempt to separate them with screens and filters. They discover that water and salt make a special kind of mixture—a solution—that cannot be separated with a filter.	Assessment 1 Session * Active Ins. 1 Session	How can a mixture be separated? Practices Planning and carrying out investigations	• A mixture is two or more materials intermingled. • An aqueous solution is a mixture in which a substance dissolves in water to make a clear liquid.	Science Notebook Entry Mixtures Separators Online Activity "Tutorial: Mixtures"	Benchmark Assessment Survey Embedded Assessment Science notebook entry
PART 2 **Separating a Salt Solution** Students add a measured amount of salt to a measured amount of water to make a solution. They compare the total mass of a mixture to the mass of its parts to infer that the invisible salt is still present. Students evaporate the salt solution to reclaim the salt as crystals.	Active Ins. 2 Sessions Reading 1 Session	Where does the solid material go when a solution is made? Practices Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations Engaging in argument from evidence	• Mixtures can be separated into their constituents. • The mass of a mixture is equal to the mass of its constituents.	Science Notebook Entry Making a Solution Science Resources Book "Mixtures" Online Activities "Tutorial: Solutions" "Tutorial: Conservation of Mass"	Embedded Assessment Response sheet
PART 3 **Separating a Dry Mixture** Students are given a dry mixture (gravel, powder, and salt) to separate. The mixture includes a new mystery material, magnetite. Students separate the mixture by using magnets, screens, filters, and evaporation. Students review the elements of engineering design as they design an efficient system to separate a dry mixture. They discuss their efforts in terms of science and engineering practices.	Active Ins. 2 Sessions Reading 1 Session	How can you separate a mixture of dry materials? Practices Defining problems Planning and carrying out investigations Analyzing and interpreting data Constructing explanations and designing solutions Engaging in argument from evidence Obtaining, evaluating, and communicating information	• Mixtures can be separated into their constituents. • Mixtures and solutions can be separated, using screens, filters, and evaporation. • Possible solutions to a problem are limited by available materials and resources (constraints). • The success of a designed solution is determined by considering the desired features of a solution (criteria).	Science Notebook Entry Answer the focus question Science Resources Book "Taking Mixtures Apart" "Science Practices" "Engineering Practices" Online Activity "Separating Mixtures" "Virtual Investigation: Separating Mixtures" Video Elements, Compounds, and Mixtures	Embedded Assessment Performance assessment
PART 4 **Outdoor Solutions** Students are challenged to discover if natural materials in the schoolyard will make solutions when mixed with water. When students observe that organic material changes the color of the water, they are introduced to the concept of an extract.	Active Ins. 1 Session Reading 1 Session Assessment 2 Sessions	Are there materials outdoors that will dissolve in water? Practices Planning and carrying out investigations Analyzing and interpreting data Constructing explanations Obtaining, evaluating, and communicating information	• A mixture is two or more materials intermingled. • An aqueous solution is a mixture in which a substance dissolves in water to make a clear liquid.	Science Notebook Entry Answer the focus question Science Resources Book "Extracts" "The Story of Salt" (optional)	Benchmark Assessment Investigation 1 I-Check NGSS Performance Expectations addressed in this investigation 5-PS1-1, 5-PS1-2 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3

* A class session is 45–50 minutes.

88 Full Option Science System Mixtures and Solutions Module—FOSS Next Generation 89

Investigation 1, Separating Mixtures
At a Glance, Pages 88-89

The *Investigations Guide* in every FOSS module helps teachers guide students in their journey of discovery.

Phenomena they can understand, and the tools to do so.

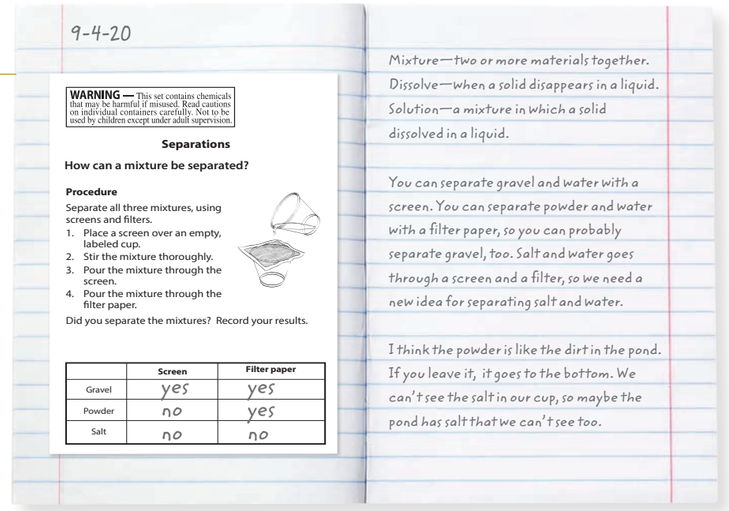
FOSS gives all students the opportunity to build understanding through their own investigations, by solving problems and explaining the anchor phenomenon.

FOSS takes care to ensure that every phenomenon used is local and relevant to your students. As they make sense of the phenomenon through a coherent sequence of activities, they use notebooks to record observations, discuss, reflect on and revise their models and explanations. In these ways and more, FOSS empowers students to comprehend and explain what they're observing, so they can deepen their understanding of the phenomena they're exploring.

"All students—including English language learners and students from cultural groups underrepresented in STEM—need phenomena that are engaging and meaningful to them. Not all students will have the same background or relate to a particular phenomenon in the same way."

Craig Gabler, Ph.D.
Member, NGSS Writing Team

Students construct an explanation of a phenomenon in their science notebook.



9-4-20

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Separations

How can a mixture be separated?

Procedure

Separate all three mixtures, using screens and filters.

1. Place a screen over an empty, labeled cup.
2. Stir the mixture thoroughly.
3. Pour the mixture through the screen.
4. Pour the mixture through the filter paper.

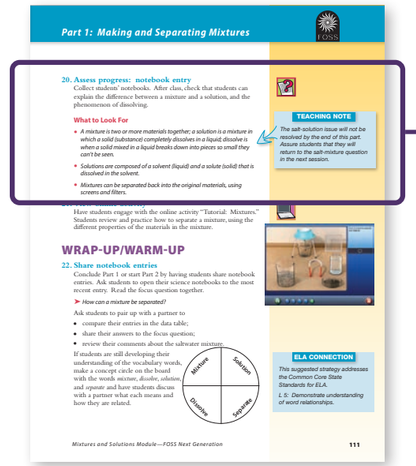
Did you separate the mixtures? Record your results.

	Screen	Filter paper
Gravel	yes	yes
Powder	no	yes
Salt	no	no

Mixture—two or more materials together.
Dissolve—when a solid disappears in a liquid.
Solution—a mixture in which a solid dissolved in a liquid.

You can separate gravel and water with a screen. You can separate powder and water with a filter paper, so you can probably separate gravel, too. Salt and water goes through a screen and a filter, so we need a new idea for separating salt and water.

I think the powder is like the dirt in the pond. If you leave it, it goes to the bottom. We can't see the salt in our cup, so maybe the pond has salt that we can't see too.



Part 1: Making and Separating Mixtures

20. Assess progress: notebook entry
Collect students' notebooks. After class, check that students can explain the difference between a mixture and a solution, and the phenomenon of dissolving.

What to Look For

- *A mixture is two or more materials together; a solution is a mixture in which a solid (substance) completely dissolves in a liquid; dissolve is when a solid mixed in a liquid breaks down into pieces so small they can't be seen.*
- *Solutions are composed of a solvent (liquid) and a solute (solid) that is dissolved in the solvent.*
- *Mixtures can be separated back into the original materials, using screens and filters.*

Have students engage with the online activity "Tutorial: Mixtures." Students review and practice how to separate a mixture, using the different properties of the materials in the mixture.

TEACHING NOTE
The salt-solution issue will not be resolved by the end of this part. Assure students that they will return to the salt-mixture question in the next session.

WRAP-UP/WARM-UP

22. Share notebook entries
Conclude Part 1 or start Part 2 by having students share notebook entries. Ask students to open their science notebooks to the most recent entry. Read the focus question together.

➤ *How can a mixture be separated?*

Ask students to pair up with a partner to

- compare their entries in the data table;
- share their answers to the focus question;
- review their comments about the saltwater mixture.

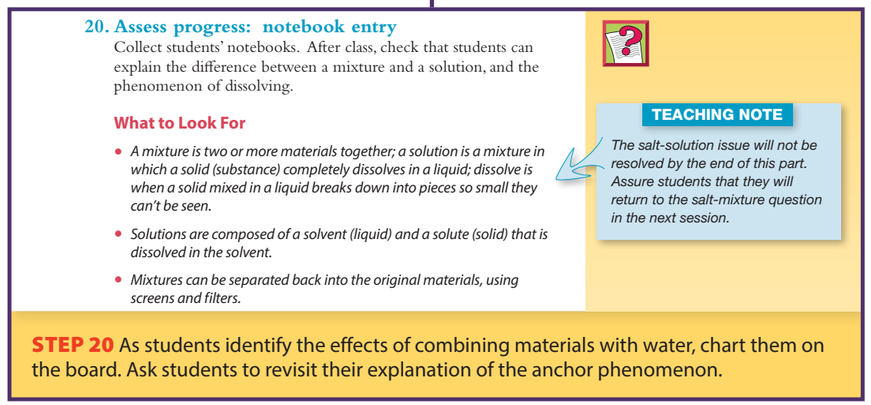
If students are still developing their understanding of the vocabulary words, make a concept circle on the board with the words *mixture*, *dissolve*, *solution*, and *separate* and have students discuss with a partner what each means and how they are related.

ELA CONNECTION
This suggested strategy addresses the Common Core State Standards for ELA.
L. 5: Demonstrate understanding of word relationships.

Mixtures and Solutions Module—FOSS Next Generation 111

Investigation 1, Part 1
Step 20, Page 111

Teachers guide the students to revisit their explanation of the anchor phenomenon.



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TEACHING NOTE
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STEP 20 As students identify the effects of combining materials with water, chart them on the board. Ask students to revisit their explanation of the anchor phenomenon.

A logical sequence designed for NGSS.

The FOSS® program is designed around learning as a developmental progression, providing experiences that allow students to build continuously on their initial notions. FOSS investigations invite students to engage with scientific ideas (content) and the practices of science and engineering, by providing a carefully curated series of firsthand experiences.

GRADE 5: *FOSS Mixtures and Solutions* Learning Progression

Driving Questions for Anchor Phenomena: What is matter? What happens when matter interacts?

ANCHOR PHENOMENON 1	ANCHOR PHENOMENON 2	ANCHOR PHENOMENON 3
What caused the formation of the pond and how do you explain the changes observed to the water and plants?	**How can you identify the mystery substance safely?**	**What causes you to burp?**
INVESTIGATIONS 1–3	**INVESTIGATION 4**	**INVESTIGATION 5**
NGSS PEs: 5-PS1-1, 5-PS1-2, 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3	**NGSS PEs: 5-PS1-1, 5-PS1-2 , 5-PS1-3, 3-5-ETS1-1, 3-5-ETS1-2**	**NGSS PEs: 5-PS1-1, 5-PS1-2, 5-PS1-3 5-PS1-4**
Students investigate the changes to water and plants in a pond after a hard rain. They begin to construct an explanation of the changes in the water by mixing three solid materials (gravel, powder, and salt) into cups of water to observe three types of mixtures, revealing a phenomenon; dissolving. Next, they use measurement tools to gather evidence that the dissolved material (salt) is still present, but not visible (conservation of matter), and develop a model for the dissolved salt in water. Then, they use evaporation to separate salt from water. They apply what they learned about separating mixtures to construct an explanation of the changes to the water that has ponded. Finally, they analyze solutions and develop a model for concentration and use this model to determine impact of concentration of solutions on plants.	Students are given a problem to determine a mystery substance. They compare the amount of different substances that dissolve in a given amount of water. They analyze the crystal signature of different substances and then plan and carry out investigations using the properties of solubility and crystal pattern to identify the mystery substance.	Students combine two substances with water to discover the a chemical reaction. They collect and analyze data about the effects of mixing different combinations of substances with water to discover that new substances with different properties form. They construct explanations about the amount of a new substance produced in different chemical reactions and apply these ideas to explain what causes a burp.

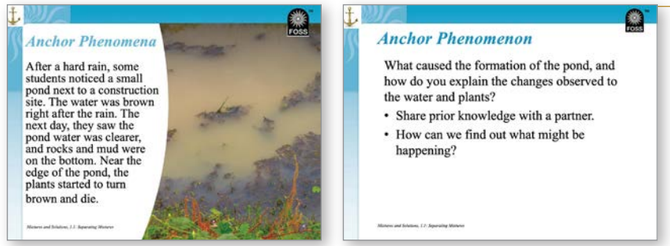
Students gain more complex science and engineering knowledge throughout a module (above) and cumulatively as they experience modules at multiple grade levels (below).

FOSS Next Generation K–8 Topic Arrangement Learning Progression

PRIOR KNOWLEDGE		FUTURE KNOWLEDGE
KINDERGARTEN	**GRADE 2**	**MIDDLE SCHOOL**
PEs: K-PS3-2, K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	**PEs: 2-PS1-1, 2-PS1-2, 2-PS1-3, 2-PS1-4, K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3**	**PEs: MS-PS1-1, MS-PS1-2, MS-PS1-3, MS-PS1-4, MS-PS1-5, MS-PS1-6, MS-PS3-3, MS-PS3-4, MS-PS3-5, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4**
In ***FOSS Materials and Motion,*** students conduct investigations to identify and compare properties of common solid materials. They learn that different properties are suited for different purposes. They use these ideas to design and build a structure with materials that will reduce the warming effect of sunlight on an area.	In ***FOSS Solids and Liquids,*** students plan and conduct investigations to describe and classify materials by their observable properties. They design, construct, and reconstruct structures (towers and bridges) using a set of objects that meet criteria. After exploring properties of liquids, they observe what happens when common materials are mixed. Finally, they explore changes to materials due to heating and cooling and argue with evidence if toothpaste is a solid or liquid.	In ***FOSS Chemical Interactions,*** students build on matter interactions, introduced in grade 5. They observe a (chemical) reaction of a mystery mixture of two solid substances and water. They conduct investigations to figure out the composition of the mystery mixture, using materials, virtual simulations, and readings. They learn about elements, atoms and molecules, phase change, kinetic energy, and the conservation of matter. They design a thermos to apply ideas related to energy transformations. As they experience different reactions, they develop models to describe the atomic composition of simple molecules and conclude by applying the ideas to the mystery mixture.

Supports for teachers help students make sense of phenomena.

Each FOSS module includes new teaching slides, created expressly to show how every anchor phenomenon ties into each investigation throughout the module.



New FOSS teaching slides show the connection between each investigation and its associated anchor phenomenon.

Teacher tools promote effective learning.

Three-dimensional learning support in each investigation equips the teacher with scientific background information specific to that investigation. Throughout, the *Teaching Children About* section makes direct connections to NGSS for the grade level.

Home/school connections include home-based activities in science and math that enable parental involvement and, as needed, remote learning.

Unmatched professional learning is provided by a network of consultants experienced in using FOSS themselves.

Teacher Resource Introductory Videos review instructional practices, such as making sense of phenomena and sense-making discussions, in the context of actual FOSS classroom lessons.

Teacher Preparation Videos guide the setup of equipment and summarize what students will do and learn.

FOSS: A vision fulfilled. Science teaching transformed.

Every student deserves the benefits of science education—not just exposure to scientific phenomena, but the opportunity to understand and explain them. From its foundation, FOSS was built to afford that opportunity to all, regardless of background culture, language, or ability.

The FOSS developers at the Lawrence Hall of Science designed FOSS around the principle of collaborative, active investigation. FOSS effectively engages all students by inviting them to interact with observable phenomena, a teaching philosophy subsequently codified with the arrival of NGSS. FOSS makes science accessible and equitable for every student in every classroom. This active learning philosophy has turned more than two million students and 100,000 teachers into hands-on active investigators of scientific phenomena. FOSS is recognized today by experts and organizations across the country for its proven quality, rigor, support, and effectiveness.

Learn more.

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FOSS™

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