



Exploring Science

Master 100% of the NGSS



Exploring Science

Built for the Next Generation Science Standards



What are the Next Generation Science Standards (NGSS)?

The NGSS were created by science educators and science organizations to update content knowledge and to incorporate practices of science. The NGSS resulted in several important shifts in the way science is taught:

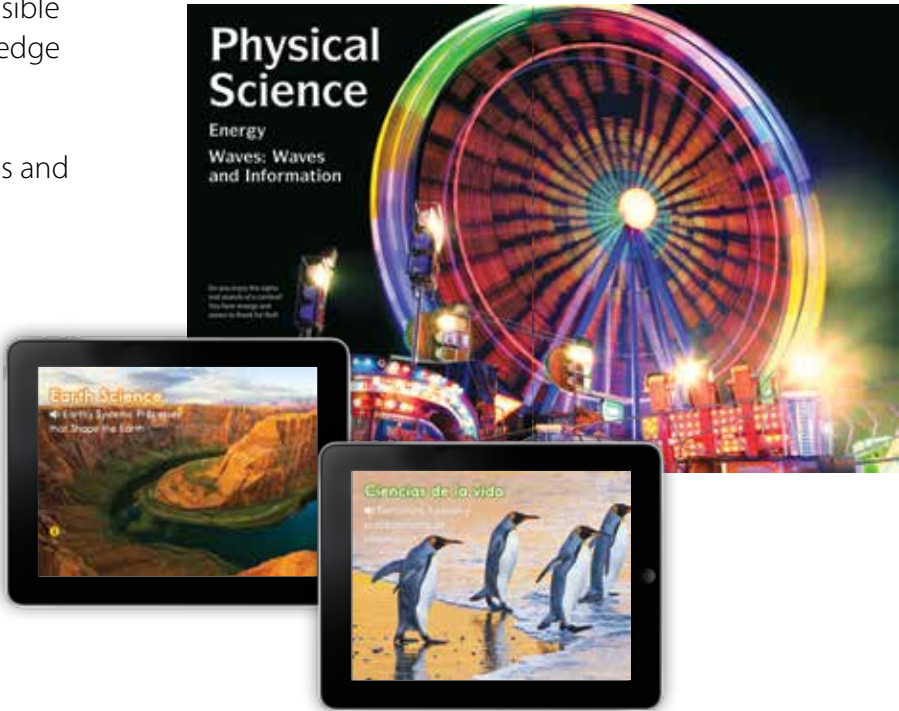
- » Shift towards the doing of science, rather than only the knowledge of science facts
- » Shift to include engineering design at all grade levels
- » Shift towards fewer standards per grade, but each covered at greater depth

How does this change how teachers will teach science?

NGSS instruction incorporates a “3-Dimensional Learning” approach where teachers are responsible for preparing students to apply science knowledge through hands-on Performance Expectations. Teachers now need to integrate core ideas of science with Science and Engineering Practices and Crosscutting Concepts.

How does *Exploring Science* help teachers make these changes?

- » Introduce Disciplinary Core Ideas through compelling text and imagery
- » Provide hands-on practice in applying the Disciplinary Core Ideas with Investigate activities
- » Assess the Performance Expectations with hands-on Science and Engineering Practices and the integration of Crosscutting Concepts



"I have watched my students grow in their learning of science and the joy of thinking outside the box. The program is amazing."

—KARINA C., MARYLAND

Teachers are provided with all of the support needed to implement and assess the NGSS. Help students master the Performance Expectations through a consistent 5E lesson model providing in-depth NGSS instruction and assessment with Engage, Explore, Explain, Elaborate, and Evaluate activities.

NGSS printed on every page

5E model for every lesson

Think Like an Engineer

Compare Multiple Solutions

Next Generation Science Standards | Disciplinary Core Ideas

ETS1C: Optimizing the Design Solution
Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (secondary to 4-PS4-3)

PERFORMANCE EXPECTATION
4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information. (Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1s and 0s representing black and white to send information about a picture, and using Morse code to send text.)

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Objectives Students will be able to:

- Generate and compare multiple solutions that use patterns to transfer information.
- Determine which of the solutions best solves the problem, given the criteria and constraints.

CLASSROOM MANAGEMENT

Materials For groups of 4: Make available a variety of materials that might be available in a cabin at summer camp, such as shoes, guide book, flyswatter, plastic combs, box of tissues, tin cup or bowl, spoons, soap in a soap box, flying disc, playing cards, empty water bottles.

Time 15 minutes for planning and setup; 15 minutes for observation and recording; 15 minutes for data analysis and interpretation; 20 minutes for sharing and explanation of results

Teaching Tips If possible, allow students to test their solutions through doors or walls.

What to Expect Students will observe that the best solution involves a method that can send a clear signal that is audible through walls.

ENGAGE

Set the Scene.

- Have students read the introduction on page 66. Ask: **What are you being asked to design?** (a solution for communicating through walls)

Define the problem.

Have students read step 1. Say: **Write Problem in your notebook. Record the problem you are trying to solve.** (The problem is a need for a way to communicate from one cabin to the next.)

- Say: **How will you determine whether your design is successful? Write Criteria in your notebook. Under that heading, list the criteria for a successful design.** (It will need to result in the accurate reception of a message.)
- Say: **What are the constraints? List the constraints of your design.** (Time is limited to the class period and materials are limited to those that are already available.)

EXPLORE

Find a solution.

- Have students read step 2. Guide students as they design a prototype and record their design in their notebook. (Possible solution: I will bang the soap box with the spoon to represent a dot and shake the soap in the soap box to represent a dash.)

Test your solution

- Have students read step 3. Have students make a table for recording their observations in their science notebook.

Example:

| Solutions for Sending a Message | | |
|---------------------------------|------------|--------------|
| Solution | What I Did | Observations |
| | | |

EXPLAIN

Refine or change your solution.

- After reading step 4, have students improve their design and record what they did each time in their notebook.

Analyze and explain your results.

- Have students analyze their results and choose the best solution to present to the class. As a class, compare and evaluate solutions. Determine which best solves the problem, and explain the criteria by which you made your decision.
- Ask: **In what ways did you think like an engineer as you completed this activity?** (Possible response: I had to find a solution to a problem using only the materials I had access to. We tried multiple codes, testing our solutions until we optimized our solution.)

ELABORATE

Invent a code.

- Have students invent their own "secret" code with a partner. Show students a few ideas to stimulate their thinking.

EVALUATE

Check to make sure students have recorded their solutions and test results in their science notebook. Then ask students these questions. Have them record the answers in their science notebook.

SCIENCE AND ENGINEERING PRACTICES

Constructing Explanations and Designing Solutions

- In this activity, students created several code systems for communicating, and compared their ideas to find the optimal solution. Have students do research about other code systems that exist in science, such as encryption, languages, or animal communication and chemical signalling. Discuss with students what the possible constraints of each of these systems are, and the possible situations where one solution works better than another.

CROSSCUTTING CONCEPTS

Patterns

- Say: **In this activity, you used Morse Code to communicate with your partner through a wall. Ask: How would your solution be affected if the wall was soundproof?** (Possible answer: We could not communicate because we could not hear a code through the wall). Then ask: **What is another way you could communicate a message without sound?** (Answers will vary, but should involve other strategies like using light, written code, or digital communication devices.)

PHYSICAL SCIENCE
Waves: Waves and Information

LIFE SCIENCE
Structure, Function, and Information Processing

EARTH SCIENCE
Earth's Systems: Processes that Shape the Earth

| Rubric | Scale |
|--|---------|
| The student designed a communication solution using a code. | 4 3 2 1 |
| The student tested the solution. | 4 3 2 1 |
| The student participated in evaluating the effectiveness of the solution and helped make changes based on testing results. | 4 3 2 1 |
| The student recorded all stages of the process. | 4 3 2 1 |
| Overall Score | 4 3 2 1 |

Student Rubric Have students complete a self-evaluation similar to that shown below.

| Rubric | Yes | Not Yet |
|---|-----|---------|
| 1. I can define a problem and identify a solution. | | |
| 2. I can test my solution. | | |
| 3. I can change my solution based on results of testing it. | | |
| 4. I can explain my solution and get ideas from others about how to improve it. | | |

66 Physical Science

67

- 3-Dimensional Learning integrates all aspects of the NGSS:
- Science and Engineering Practices
 - Crosscutting Concepts
 - Disciplinary Core Ideas
- Assessment opportunities include:
- Teacher and Student rubrics to assess Performance Expectations
 - Evaluate sections to assess Disciplinary Core Ideas
 - Unit Disciplinary Core Ideas review questions

Hands-on for NGSS and STEM

Exploring Science is designed to prepare students for the rigor of the Performance Expectations in the NGSS allowing teachers to address STEM and the NGSS in one program!

Exploring Science lessons start by introducing Disciplinary Core Ideas, then provides students opportunity to practice applying those ideas through hands-on Investigate activities.

Teachers are provided complete guidance and support for hands-on activities to ensure successful implementation of the NGSS.

Hands-on materials kits are available separately.

Simple materials are easy to obtain and work with

Step by step instructions for students

Students use their own Science Notebooks to record observations and data

Investigate

Weathering and Erosion

How can you model the processes of weathering and erosion?

Scientists use various kinds of models to investigate how natural processes work. In this activity you'll explore two ways that weathering and erosion can change a rock called sandstone.

Materials

| | | |
|-----------|-------------|--------------|
| sandstone | paper towel | jar with lid |
| water | hand lens | stopwatch |

Look at the photo. How might weathering and erosion have changed these rocks?

SCIENCE in a SNAP

Time to Sort

- Find objects like these in your classroom.
- Sort the objects by texture. Are they rough or smooth?
- Tell what other objects in your classroom have a rough or smooth texture.

1 Predict what will happen when you rub 2 pieces of sandstone together. Record your prediction in your science notebook. Hold the pieces of sandstone over the paper towel. Rub them together for a few seconds. Observe what happens. Record your observations.

2 Place 5 pieces of sandstone in a jar. Pour water into the jar to fill it about half full. Put the lid on the jar securely. Use the hand lens to observe the sandstone and the bottom of the jar. Record your observations.

3 Predict what will happen if you shake the jar. Then shake the jar for 3 minutes. Use the stopwatch to time yourself.

4 Observe the sandstone and the bottom of the jar. Record your observations.

Wrap It Up!

- Compare** How do your results compare to your predictions? Explain.
- Analyze** What processes did you model in Steps 1 and 3? Explain.
- Apply** Use what you learned in this investigation to explain how the rocks in the picture were changed.

Grade 4

Assessment for every lesson

Quick "Science in a Snap" activities engage students and demonstrate Disciplinary Core Idea phenomena

Materials and tips help prepare teachers for hands-on activities

NGSS and lesson objective printed on every page

5E model for every lesson

Investigate

Weathering and Erosion

Next Generation Science Standards | Disciplinary Core Ideas
ESS2.A: Earth Materials and Systems: Waves, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (A-ESS2-5)

Objectives Students will be able to:

- Model the processes of weathering and erosion.
- Describe how weathering and erosion can change the land.

EXPLORE

- Have students wear safety goggles.
- Guide students through the investigation. Read pages 118–119 together.

Have students construct a table in their science notebook to record their observations.

Example:

| | Predictions | Observations |
|---|-------------|--------------|
| sandstone pieces being rubbed together | | |
| sandstone pieces being shaken in a jar of water | | |

ELABORATE

- Remind students that in this investigation, they explored how pieces of sandstone reacted when rubbed together or tossed about in water. Ask students to think about how other types of rocks might react under the same circumstances. Ask probing questions to encourage exploration. For example, ask: **How do you think a very soft rock, such as chalk, might react to being rubbed or tossed in water? A very hard rock? How do you think the hardness of a rock affects how quickly it is weathered and eroded?**
- If time permits, have different groups experiment with rocks of different hardness and share their results.

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

- COMPARE** How do your results compare to your predictions? Explain. (Answers will vary. Some students may have predicted that both rubbing and shaking in water would cause pieces of the sandstone to break off.)

CLASSROOM MANAGEMENT

Materials For groups of 4: 5 pieces of sandstone; paper towel; pitcher; water; jar with lid (16 oz); hand lens; stopwatch

Time 30 minutes

Advance Preparation Fill the pitcher with water.

Teaching Tips Remind students to tightly screw the jar lids on before shaking. Have students take turns rubbing the sandstone and shaking the jars. Model lab safety by wearing your safety goggles.

What to Expect Students will observe bits of rock or sand broken off by the physical weathering that occurs when rubbing and shaking sandstone rocks together. Students should observe sand particles settle to the bottom of the jar.

ENGAGE

Tap Prior Knowledge

- Ask students to describe examples of weathering, such as rocks or sidewalks that have been cracked, or rocks that have been worn smooth. Remind them that weathering is the breaking apart, wearing away, or dissolving of rock into smaller particles called sediment. Then ask them to describe examples of erosion, such as the way soil moves in a riverbed or down a mountain in the rain. Remind them that erosion happens when sediment is picked up and moved to a new place.

EXPLAIN

- Have students share predictions, observations, and ideas within groups and with the class. Ask: **Did your results support your predictions? Explain.** (Answers will vary. Have students provide evidence that either supports or refutes their predictions.)

READING CONNECTION

Describe Text Structure

Remind students that the way a piece of writing is organized is called its text structure. Guide students to review how information in an investigation is organized. After tapping students' prior knowledge, you might want to preview the text and ask students to point out what they observe. Ask: **What is provided in the text to help you with this investigation?** (Students may point out the bold question, which tells them what the investigation is about. They may also identify the materials list, which tells them what items they will need to carry out the investigation, as well as the numbered steps, which tell them what to do in the investigation.) Remind students that all investigations in the student book have a similar text structure.

Data tables provided in Teacher's Guide and as separate Learning Masters for student use

Literacy support for every lesson

“The activities are hands on, engaging, and reach all levels of learners.”

—LAURA F., NEW JERSEY

Interactive Technology

Turn the NGSS into an engaging student experience with the most interactive and powerful digital program available.

Transform student learning with the *Exploring Science* Interactive eBook:

- » Highly engaging, content-based activities at point-of-use
- » Enhanced content with videos, animations, and simulations
- » Improve student understanding with interactive content and vocabulary activities



Bones and Muscles of an Elephant

The internal structures of an elephant include its bones and muscles. Bones support the elephant's body and protect its internal organs. All of the bones in an elephant make up its skeleton. Muscles are attached to bones and work with the bones to move parts of the elephant's body.

Audio support for English and Spanish versions

Info Pop-Ups reveal additional content and features

Interactivity supports NGSS content and practices

Wrap It Up! provides ongoing assessment opportunities

Content practice with vocabulary matching activities

Interactive vocabulary with pop-up definitions

Embedded videos support Disciplinary Core Ideas from the NGSS, at point-of-use

Digital Notebook

Exploring Science encourages notebooking for students to record their observations and data, to answer Wrap It Up! lesson questions, to ask their own questions, and to create drawings and writing based on the NGSS.

The digital notebook is another opportunity for students to answer questions and practice the core ideas of the NGSS.



Drawing tools allow students to answer Wrap It Up! questions and express knowledge of the NGSS through visuals

Save drawings for review later

Content Review Activities and Games

Wrap It Up! activities include interactive content review with instant student feedback:

- » Matching
- » Sequencing / ordering
- » Fill in the blank
- » Categorizing
- » Labeling
- » Multiple Choice



Teacher Resources

Learning and Assessment Masters in English and Spanish include:

- » Teacher rubrics
- » Student rubrics
- » Data tables
- » Black line masters

ExamView Assessment:

- » Create and customize tests based on Disciplinary Core Ideas from the NGSS
- » Print or export tests



Online Teacher's Guide


View a sample of the Interactive eBook at: NGL.Cengage.com/ExploringScienceSample

Go into the Field with National Geographic Explorers

Students learn real-world applications of the Disciplinary Core Ideas and practices of the NGSS from National Geographic Explorers and scientists. These diverse individuals model for students how science content and engineering concepts help solve real-world problems.

- » Inspire students to think and act like real scientists and engineers
- » Travel with Explorers to the field through interviews and case study stories
- » Learn about exciting careers in science and engineering

These Explorers are on the cutting edge of their fields, making discoveries and pushing scientific boundaries in order to bring back their inspiring stories to share with students within *Exploring Science*.



**NATIONAL
GEOGRAPHIC
LEARNING**

Science Career

Explorer

Shafqat Hussain


is a wildlife expert.

He works to protect snow leopards.

Snow leopards sometimes hunt farmers' goats.

Shafqat talks to farmers.

He finds ways to keep the farmers from killing the snow leopards.



**NATIONAL
GEOGRAPHIC
LEARNING**

Science Career

Explorer

Barrington Irving

is a pilot.

Pilots need to understand motion.

Barrington became interested in flying planes when he was 15 years old.

At 23, he was the youngest person to fly alone around the world.

Today he teaches children about science and technology.

30 NEXT GENERATION SCIENCE STANDARDS | CONNECTIONS TO NATURE OF SCIENCE

Scientific Knowledge is Based on Empirical Evidence

Scientists look for patterns and order when making observations about the world.

Grade K

Think Like an Engineer

Case Study

Finding Solutions to Energy Problems

Problem

T.H. Culhane helps people all over the world meet their energy needs. T.H. is an expert in finding solutions to energy problems. He got his start studying people in the rain forests of Borneo. The people had few resources available, yet they thrived in their environment. T.H. thought, "How can we use the idea of working with limited resources to do the same thing in the cities?" Let's talk with T.H. about some of his environmental and health solutions.

NGL Science Why did you go to rain forests?

T.H. Culhane I learned that people who live in the rain forest get all of their energy, all their food, and all their services—recycling their wastes back into even from the forest. I went to live with them to learn about it.

NGL Science Your work takes you all over the world. How do you always try to find sustainable energy solutions, that mean?

Next Generation Science Standards | Disciplinary Core Idea 4-ETS-1: Defining Engineering Problems

Possible solutions to a problem are limited by available materials and resources. The feasibility of a proposed solution is determined by considering the desired features of a solution to the problem. Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for solving the problem.

Science Career

Research Scientist

Genghis Khan was a legendary ruler and warrior. In the early 13th century, he founded the largest empire in the known world. It is thought that he died in 1227 during a military battle, but the details of his death remain a mystery. His tomb has never been found.

That is where Dr. Albert Yu-Min Lin comes in. As a research scientist, he plans and carries out scientific investigations. Albert wants to know what happened to Genghis Khan, and he wants the public to help him. In his work with the Valley of the Khans Project, he uses a technique called crowdsourcing. This means he invites people all over the world to help him search through huge amounts of satellite imagery data for clues.

Explorer

Thomas Taha Rassam Culhane

is an urban planner. His organization, Solar CITIES, invests in creative solutions for people's sanitation and energy problems. T.H. has gotten firsthand experience living in places where people have little money to invest in energy and other sustainability technologies.

Explorer

Albert Yu-Min Lin

is a research scientist at the University of California, San Diego. His quest for Genghis Khan's tomb is featured in a documentary called *The Forbidden Tomb of Genghis Khan* and has taken him to some of the most isolated areas in the world. Albert also enjoys public speaking, mountain climbing, surfing, and photography.

Conservationist

To conserve something means to save it or protect it. A conservationist protects wildlife. Beverly and Derek Joubert are career conservationists.

The Jouberts explore Africa. They do research and make films. The Jouberts share what they learn with others. They hope other people will want to protect wildlife, too.

Albert navigates a computer model of terrain in a virtual reality environment called the StarCave.

The wall of computer screens behind Albert displays the most detailed satellite images available. The display shows part of Mongolia, a very challenging place to explore.

Grade 5

NGSS Content and Literacy Support

The *Exploring Science through Literacy* program supports *Exploring Science* and the Disciplinary Core Ideas from the NGSS. Multiple reading levels provide core idea content and National Geographic images capture student interest. Online Teacher’s Guides support science content and literacy skills in the same lesson.

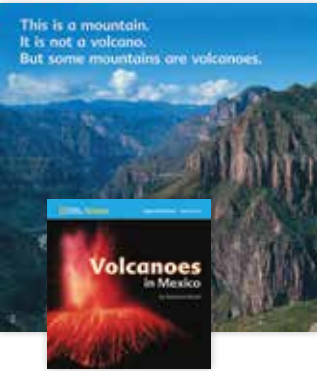
Grades K–2

Support reading skills development and introduce core ideas in science topics based on the NGSS. All levels available in English and Spanish.



Become an Expert

- » Designed for small group reading
- » Three reading levels on the same Big Ideas topic
- » Groups share and compare what they learn from their title



Explore On Your Own

- » Designed for independent reading
- » Three reading levels on the same Big Ideas topic
- » Further exploration on topics that interest students



Write About Big Books

- » Models persuasive writing
- » Used as a basis for students to write their own science opinion piece

Grades 3–5

Continue more advanced literacy skills development while engaging with amazing National Geographic images and Explorers who introduce students to real-world science in English and Spanish.



- » Designed for whole class or small group reading
- » Identical content and images at 3 reading levels per title (Spanish available on-level only)
- » Each title contains 3–4 articles written in a variety of genres
- » High-interest, student-centered topics

Online Teacher’s Guides

- Literacy and science content program support.
- » Introduce science background and vocabulary
 - » Combine science content and literacy instruction in one lesson
 - » Includes ELL support
 - » Additional writing and research activities increase engagement

Use *Exploring Science through Literacy* to supplement *Exploring Science*

During instruction from *Exploring Science*, use related *Exploring Science through Literacy* titles to extend informational text reading and expand science content knowledge on specific Disciplinary Core Ideas.



Use *Exploring Science* as the basis for Disciplinary Core Idea instruction

- Grade 3 Example
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS4.D: Biodiversity and Humans



Use *Exploring Science through Literacy* to extend reading on the same topic

- Grade 3 Example
- Tropical Rain Forest Adventure

“I love science, and I love this book!
I even read it when I’m not supposed to!”

—2ND GRADE STUDENT, MARYLAND

Components

Kindergarten



Interactive eBook



Big Books (Life, Earth, and Physical)

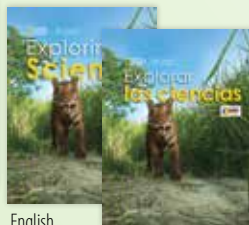


Teacher's Guide

Grade 1



Interactive eBook



English Student Book Spanish Student Book



Teacher's Guide

Grade 2



Interactive eBook



English Student Book Spanish Student Book



Teacher's Guide

Grade 3



Interactive eBook



English Student Book Spanish Student Book



Teacher's Guide

Grade 4



Interactive eBook



English Student Book Spanish Student Book



Teacher's Guide

Grade 5




Interactive eBook



English Student Book Spanish Student Book



Teacher's Guide

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