Natural Hazards

STEM Road Map for Elementary School

Edited by Carla C. Johnson,
Janet B. Walton, and Erin Peters-Burton

NSTA press
National Science Teaching Association

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1840 Wilson Blvd., Arlington, VA 22201
www.nsta.org/store
For customer service inquiries, please call 800-277-5300.

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NATURAL HAZARDS MODULE OVERVIEW

Andrea R. Milner, Vanessa B. Morrison, Janet B. Walton, Carla C. Johnson, and Erin Peters-Burton

THEME: Cause and Effect

LEAD DISCIPLINE: Science

MODULE SUMMARY

In this module, students learn about the effects of natural hazards on people, communities, and the environment and consider how threats to human safety from natural hazards can be minimized. They also explore the economic effects of natural hazards from the perspectives of human and natural resources. Student teams are challenged to create a plan for how people can prepare for a natural hazard to minimize its impacts on the environment and on humans (adapted from Koehler, Bloom, and Milner 2015).

ESTABLISHED GOALS AND OBJECTIVES

The goal of this module is for students to understand and demonstrate their knowledge about the influence of natural hazards on people and on other animals. At the conclusion of this module, students will be able to do the following:

- Identify various natural hazards
- Identify the basic causes of natural hazards
- Use technology to gather research information and communicate
- Identify ways that natural hazards can impact people and communities
- Identify features of structures designed to withstand earthquakes and construct models of structures that incorporate these types of features
- Identify ways that natural hazards can impact animals' homes
- Model natural hazards

- Identify the steps of the engineering design process (EDP)
- Use the EDP to complete team projects
- Identify effective collaboration practices and reflect on their teams' efforts to collaborate
- Identify models for measuring, calculating, comparing, and evaluating numbers related to the probabilities of weather occurrences
- Identify bar graphs and infographics as ways that numbers can be displayed graphically
- Create bar graphs and infographics for data sets
- Identify ways that people and communities can prepare for natural hazards to mitigate their impacts on people and property
- Communicate information about natural hazards and natural hazard preparedness to a target audience
- Identify tall tales as a type of fictional literature and create their own tall tales
- Identify the basic parts of a story

CHALLENGE OR PROBLEM FOR STUDENTS TO SOLVE: NATURAL HAZARD PREPAREDNESS CHALLENGE

Students are challenged to work in teams to develop and communicate a plan for people to prepare for one type of natural hazard, such as a flood, tornado, earthquake, volcano, wildfire, thunderstorm, or hurricane. The plan should focus on keeping people safe if a natural hazard should strike their community. As part of this plan, students produce a public service announcement about how the community can prepare for the natural hazard.

CONTENT STANDARDS ADDRESSED IN THIS STEM ROAD MAP MODULE

A full listing with descriptions of the standards this module addresses can be found in Appendix C. Listings of the particular standards addressed within lessons are provided in a table for each lesson in Chapter 4.

STEM RESEARCH NOTEBOOK

Each student should maintain a STEM Research Notebook, which will serve as a place for students to organize their work throughout this module (see p. 12 for more general

discussion on setup and use of the notebook). All written work in the module should be included in the notebook, including records of students' thoughts and ideas, fictional accounts based on the concepts in the module, and records of student progress through the EDP. The notebooks may be maintained across subject areas, giving students the opportunity to see that although their classes may be separated during the school day, the knowledge they gain is connected. The lesson plans for this module contain STEM Research Notebook Entry sections (numbered 1–31), and templates for each notebook entry are included in Appendix A (p. 119).

Emphasize to students the importance of organizing all information in a Research Notebook. Explain to them that scientists and other researchers maintain detailed Research Notebooks in their work. These notebooks, which are crucial to researchers' work because they contain critical information and track the researchers' progress, are often considered legal documents for scientists who are pursuing patents or wish to provide proof of their discovery process.

MODULE LAUNCH

Following agreed-upon rules for discussions, hold a whole-class discussion about natural hazards, asking students questions such as the following:

- What are natural hazards?
- Are there different types of natural hazards?
- What kinds of natural hazards are there?
- What causes natural hazards?
- Can people make or cause natural hazards?
- Where and when have you seen natural hazards?

This discussion gives students an opportunity to express their conceptions of natural hazards and the influence of natural hazards. Show a video about natural hazards such as "Natural Disasters" at *www.youtube.com/watch?v=_smJ13x90oM*. Then, hold a class discussion about the various natural hazards featured in this video.

PREREQUISITE SKILLS FOR THE MODULE

Students enter this module with a wide range of preexisting skills, information, and knowledge. Table 3.1 (p. 26) provides an overview of prerequisite skills and knowledge that students are expected to apply in this module, along with examples of how they apply this knowledge throughout the module. Differentiation strategies are also provided for students who may need additional support in acquiring or applying this knowledge.

Table 3.1. Prerequisite Key Knowledge and Examples of Applications and Differentiation Strategies

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Support
Science • Understand cause and effect.	*Science* • Determine how natural hazards affect humans, communities, and animals' homes.	*Science* • Provide demonstrations of cause and effect (e.g., dropping egg [cause] and observing breakage [effect]), emphasizing that cause is why something happens, effect is what happens. • Read aloud picture books to class and have students identify cause-and-effect sequences. • Create a class T-chart to record causes and related effects students observe in the classroom, in nature, and in literature.
Mathematics • Demonstrate number sense.	*Mathematics* • Measure, calculate, compare, and evaluate numbers when exploring natural hazards.	*Mathematics* • Model measurement techniques using standard and nonstandard units of measurement. • Read aloud nonfiction texts about temperature, rainfall, wind, and measurement. • Provide opportunities for students to practice measurement in a variety of settings (e.g., in the classroom and outdoors).
Language and Inquiry Skills • Visualize. • Make predictions. • Record ideas and information using words and pictures. • Ask and respond to questions.	*Language and Inquiry Skills* • Make and confirm or reject predictions. • Share thought processes through keeping a notebook, asking and responding to questions, and using the engineering design process.	*Language and Inquiry Skills* • As a class, make predictions when reading fictional texts. • Model the process of using information and prior knowledge to use predictions. • Provide samples of notebook entries.
Speaking and Listening • Participate in group discussions.	*Speaking and Listening* • Engage in collaborative group discussions in the development of natural hazard plans and about how to communicate those plans.	*Speaking and Listening* • Model speaking and listening skills. • Create a class list of good listening and good speaking skills. • Read picture books that feature collaboration and teamwork.

POTENTIAL STEM MISCONCEPTIONS

Students enter the classroom with a wide variety of prior knowledge and ideas, so it is important to be alert to misconceptions, or inappropriate understandings of foundational knowledge. These misconceptions can be classified as one of several types: "preconceived notions," opinions based on popular beliefs or understandings; "nonscientific beliefs," knowledge students have gained about science from sources outside the scientific community; "conceptual misunderstandings," incorrect conceptual models based on incomplete understanding of concepts; "vernacular misconceptions," misunderstandings of words based on their common use versus their scientific use; and "factual misconceptions," incorrect or imprecise knowledge learned in early life that remains unchallenged (NRC 1997, p. 28). Misconceptions must be addressed and dismantled for students to reconstruct their knowledge, and therefore teachers should be prepared to take the following steps:

- *Identify students' misconceptions.*
- *Provide a forum for students to confront their misconceptions.*
- *Help students reconstruct and internalize their knowledge, based on scientific models. (NRC 1997, p. 29)*

Keeley and Harrington (2010) recommend using diagnostic tools such as probes and formative assessment to identify and confront student misconceptions and begin the process of reconstructing student knowledge. Keeley's *Uncovering Student Ideas in Science* series contains probes targeted toward uncovering student misconceptions in a variety of areas and may be a useful resource for addressing student misconceptions in this module.

Some commonly held misconceptions specific to lesson content are provided with each lesson so that you can be alert for student misunderstanding of the science concepts presented and used during this module. The American Association for the Advancement of Science has also identified misconceptions that students frequently hold regarding various science concepts (see the links at *http://assessment.aaas.org/topics*).

SRL PROCESS COMPONENTS

Table 3.2 (p. 28) illustrates some of the activities in the Natural Hazards module and how they align with the self-regulated learning (SRL) process before, during, and after learning.

Table 3.2. SRL Process Components

Learning Process Components	Examples From Natural Hazards Module	Lesson Number and Learning Component
BEFORE LEARNING		
Motivates students	Students brainstorm about natural hazards before watching a video on the subject.	Lesson 1, Introductory Activity/Engagement
Evokes prior learning	While watching a video, students document their own experiences with natural hazards.	Lesson 1, Introductory Activity/Engagement
DURING LEARNING		
Focuses on important features	Students participate in the Earthquake Shake activity, in which they simulate earthquake conditions and observe the effects of the earthquake on various structures. Students use the most earthquake-resistant designs to identify important design features.	Lesson 2, Activity/ Exploration
Helps students monitor their progress	Students create simulated earthquakes and earthquake-resistant structures using the Define, Learn, Plan, Try, Test, and Decide steps of the engineering design process, and then share their products. During the Test step, students decide whether to improve their designs based on the structures' earthquake resistance.	Lesson 2, Activity/ Exploration
AFTER LEARNING		
Evaluates learning	Students present public service announcements about how to prepare for a natural disaster and receive peer feedback to improve their products before video recording them for viewing by other students and parents.	Lesson 3, Explanation
Takes account of what worked and what did not work	The whole class discusses and analyzes strengths and weaknesses of each group's natural hazard preparedness plan. Groups can meet to improve and adapt their plans based on discussion.	Lesson 3, Elaboration/ Application of Knowledge

STRATEGIES FOR DIFFERENTIATING INSTRUCTION WITHIN THIS MODULE

For the purposes of this curriculum module, differentiated instruction is conceptualized as a way to tailor instruction—including process, content, and product—to various student needs in your class. A number of differentiation strategies are integrated into lessons across the module. The problem- and project-based learning approach used in the lessons is designed to address students' multiple intelligences by providing a variety of entry points and methods to investigate the key concepts in the module (for example, investigating solar power from the perspectives of science and social issues via scientific inquiry, literature, journaling, and collaborative design). Differentiation strategies for students needing support in prerequisite knowledge can be found in Table 3.1 (p. 26). You are encouraged to use information gained about student prior knowledge during introductory activities and discussions to inform your instructional differentiation. Strategies incorporated into this lesson include flexible grouping, varied environmental learning contexts, assessments, compacting, tiered assignments and scaffolding, and mentoring. The following websites may be helpful resources for differentiated instruction:

- *http://steinhardt.nyu.edu/scmsAdmin/uploads/005/120/Culturally%20Responsive%20Differientiated%20Instruction.pdf*
- *http://educationnorthwest.org/sites/default/files/12.99.pdf*

Flexible Grouping. Students work collaboratively in a variety of activities throughout this module. Grouping strategies you might employ include using student-led grouping, grouping students according to ability level or common interests, grouping students randomly, or grouping them so that students in each group have complementary strengths (for instance, one student might be strong in mathematics, another in art, and another in writing).

Varied Environmental Learning Contexts. Students have the opportunity to learn in various contexts throughout the module, including alone, in groups, in quiet reading and research-oriented activities, and in active learning in inquiry and design activities. In addition, students learn in a variety of ways, including through doing inquiry activities, journaling, reading texts, watching videos, participating in class discussion, and conducting web-based research.

Assessments. Students are assessed in a variety of ways throughout the module, including individual and collaborative formative and summative assessments. Students have the opportunity to produce work via written text, oral and media presentations, and modeling. You may choose to provide students with additional choices of media for their products (for example, PowerPoint presentations, posters, or student-created websites or blogs).

Compacting. Based on student prior knowledge, you may wish to adjust instructional activities for students who exhibit prior mastery of a learning objective. Since student work in science is largely collaborative throughout the module, this strategy may be most appropriate for mathematics, social studies, or ELA activities. You may wish to compile a classroom database of research resources and supplementary readings for different reading levels and on a variety of subjects related to the module's topic to provide opportunities for students to undertake independent reading.

Tiered Assignments and Scaffolding. Based on your awareness of student ability, understanding of concepts, and mastery of skills, you may wish to provide students with variations on activities by adding complexity to assignments or providing more or fewer learning supports for activities throughout the module. For instance, some students may need additional support in identifying key search words and phrases for web-based research or may benefit from cloze sentence handouts to enhance vocabulary understanding. Other students may benefit from expanded reading selections and additional reflective writing or from working with manipulatives and other visual representations of mathematical concepts. You may also work with your school librarian to compile a classroom database of research resources and supplementary readings for different reading levels and on a variety of topics related to the module challenge to provide opportunities for students to undertake independent reading. You may find the following website on scaffolding strategies helpful: *www.edutopia.org/blog/scaffolding-lessons-six-strategies-rebecca-alber.*

Mentoring. As group design teamwork becomes increasingly complex throughout the module, you may wish to have a resource teacher, older student, or volunteer work with groups that struggle to stay on task and collaborate effectively.

STRATEGIES FOR ENGLISH LANGUAGE LEARNERS

Students who are developing proficiency in English language skills require additional supports to simultaneously learn academic content and the specialized language associated with specific content areas. WIDA (2012) has created a framework for providing support to these students and makes available rubrics and guidance on differentiating instructional materials for English language learners (ELLs). In particular, ELL students may benefit from additional sensory supports such as images, physical modeling, and graphic representations of module content, as well as interactive support through collaborative work. This module incorporates a variety of sensory supports and offers ongoing opportunities for ELL students to work collaboratively.

When differentiating instruction for ELL students, you should carefully consider the needs of these students as you introduce and use academic language in various language domains (listening, speaking, reading, and writing) throughout this module. To adequately differentiate instruction for ELL students, you should have an understanding

of the proficiency level of each student. The following five overarching preK–5 WIDA learning standards are relevant to this module:

- Standard 1: Social and Instructional Language. Focus on following directions, personal information, collaboration with peers.
- Standard 2: The Language of Language Arts. Focus on nonfiction, fiction, sequence of story, elements of story.
- Standard 3: The Language of Mathematics. Focus on basic operations, number sense, interpretation of data, patterns.
- Standard 4: The Language of Science. Focus on forces in nature, scientific process, Earth and sky, living and nonliving things, organisms and environment, weather.
- Standard 5: The Language of Social Studies. Focus on community workers, homes and habitats, jobs and careers, representations of Earth (maps and globes).

SAFETY CONSIDERATIONS FOR THE ACTIVITIES IN THIS MODULE

The safety precautions associated with each investigation are based in part on the use of the recommended materials and instructions, legal safety standards, and better professional safety practices. Selection of alternative materials or procedures for these investigations may jeopardize the level of safety and therefore is at the user's own risk. Remember that an investigation includes three parts: (1) setup, in which you prepare the materials for students to use; (2) the actual hands-on investigation, in which students use the materials and equipment; and (3) cleanup, in which you or the students clean the materials and put them away for later use. The safety procedures for each investigation apply to all three parts. For more general safety guidelines, see the Safety in STEM section in Chapter 2 (p. 18).

We also recommend that you go over the safety rules that are included as part of the safety acknowledgment form with your students before beginning the first investigation. Once you have gone over these rules with your students, have them sign the safety acknowledgment form. You should also send the form home with students for parents or guardians to read and sign to acknowledge that they understand the safety procedures that must be followed by their children. A sample elementary safety acknowledgment form can be found on the National Science Teaching Association's Safety Portal at *http://static.nsta.org/pdfs/SafetyAcknowledgmentForm-ElementarySchool.pdf*.

DESIRED OUTCOMES AND MONITORING SUCCESS

The desired outcome for this module is outlined in Table 3.3, along with suggested ways to gather evidence to monitor student success. For more specific details on desired outcomes, see the Established Goals and Objectives sections for the module (p. 23) and individual lessons.

Table 3.3. Desired Outcome and Evidence of Success in Achieving Identified Outcome

Desired Outcome	Evidence of Success	
	Performance Tasks	Other Measures
Students will understand and can demonstrate their knowledge about the influence of natural hazards on people and on animals' homes.	• Students complete a variety of investigations related to natural hazards. • Student teams develop and communicate natural hazard preparedness plans. • Students each maintain a STEM Research Notebook that includes what they have learned, responses to questions, and observations.	Students are assessed using the Observation, STEM Research Notebook, and Participation Rubric.

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NATURAL HAZARDS LESSON PLANS

Andrea R. Milner, Vanessa B. Morrison, Janet B. Walton, Carla C. Johnson, and Erin Peters-Burton

Lesson Plan 1: Let's Explore Natural Hazards

In this lesson, students explore natural hazards and their causes, with the aim of understanding that various types of natural hazards occur around the world, and these hazards can be classified as those with weather-related causes and those caused by movements within Earth. Students explore tornadoes as an example of a natural hazard caused by weather.

ESSENTIAL QUESTIONS

- What are natural hazards?
- What are the different types of natural hazards?
- What causes natural hazards?
- Can people make or cause natural hazards?
- What impact do natural hazards have on people?
- What natural hazards are caused by weather?

ESTABLISHED GOALS AND OBJECTIVES

At the conclusion of this lesson, students will be able to do the following:

- Identify various natural hazards
- Identify the basic causes of natural hazards
- Identify examples of physical models
- Understand that mathematical models are used to predict weather
- Create a model of tornado winds

- Use a model to explain the behavior of debris in a tornado
- Identify several impacts natural hazards can have on people and communities
- Identify ways that mathematics can be used to describe natural phenomena
- Identify the characteristics of a tall tale
- Identify the basic parts of a story
- Create a tall tale related to weather events

TIME REQUIRED

- 7 days (approximately 30 minutes each day; see Tables 3.6–3.7, pp. 37 and 38)

MATERIALS

Required Materials for Lesson 1

- STEM Research Notebooks (1 per student; see p. 24 for STEM Research Notebook information)
- Computer with internet access for viewing videos
- 2 sheets of plain white paper (per student)
- 3 sheets of lined writing paper (per student)
- Books:
  - *Violent Weather: Thunderstorms, Tornadoes, and Hurricanes,* by Andrew Collins (National Geographic Children's Books, 2006)
  - *Hurricanes (Real World Math: Natural Disasters series),* by Barbara A. Somervill (Cherry Lake, 2012)
  - *That's a Possibility!: A Book About What Might Happen,* by Bruce Goldstone (Henry Holt and Co., 2013)
  - *Cloudy With a Chance of Meatballs,* by Judi Barrett (Atheneum Books for Young Readers, 1982)
  - *Flood Warning (Let's-Read-and-Find-Out Science 2),* by Katharine Kenah (HarperCollins, 2016)
- Chart paper
- Markers

- Map or globe
- Crayons for use in STEM Research Notebook entries (1 set per student)
- Safety glasses or indirectly vented chemical splash goggles, nonlatex aprons, and nonlatex vinyl gloves (per student)

Additional Materials for Vortex Bottle Investigation (per pair of students)

- Water (about 2 ½ cups)
- Clear 2 liter plastic bottle with label removed and a cap
- Glitter (about 2 tablespoons)
- Dishwashing liquid (about 1 teaspoon)
- 3 paper towels

SAFETY NOTES

1. All students must wear sanitized indirectly vented chemical-splash goggles, nonlatex aprons, and vinyl gloves during all phases of this inquiry activity.
2. Keep away from electrical receptacles when using water to avoid shock hazard.
3. Keep glitter away from eyes and mouths.
4. Immediately clean up any spills on the floor to avoid a slip-and-fall hazard.
5. Wash hands with soap and water after completing the cleanup phase of the activity.

CONTENT STANDARDS AND KEY VOCABULARY

Table 4.1 lists the content standards from the *Next Generation Science Standards (NGSS), Common Core State Standards (CCSS),* National Association for the Education of Young Children (NAEYC), and the Framework for 21st Century Learning that this lesson addresses, and Table 4.2 (p. 50) presents the key vocabulary. Vocabulary terms are provided for both teacher and student use. Teachers may choose to introduce some or all of the terms to students.

Table 4.1. Content Standards Addressed in STEM Road Map Module Lesson 1

NEXT GENERATION SCIENCE STANDARDS

PERFORMANCE EXPECTATIONS

- 2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

SCIENCE AND ENGINEERING PRACTICES

Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.

Developing and Using Models

Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions.

- Use a model to represent relationships in the natural world.

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Make observations (firsthand or from media) to collect data that can be used to make comparisons.

DISCIPLINARY CORE IDEAS

LS1.C. Organization for Matter and Energy Flow in Organisms

- 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.

Continued

Table 4.1. (*continued*)

ESS3.A. Natural Resources

- Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.

ESS2.D. Weather and Climate

- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

CROSSCUTTING CONCEPTS

Patterns

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Systems and System Models

- Systems in the natural and designed world have parts that work together.

Cause and Effect

- Events have causes that generate observable patterns.

COMMON CORE STATE STANDARDS FOR MATHEMATICS

MATHEMATICAL PRACTICES

- MP1. Make sense of problems and persevere in solving them.
- MP2. Reason abstractly and quantitatively.
- MP3. Construct viable arguments and critique the reasoning of others.
- MP4. Model with mathematics.
- MP5. Use appropriate tools strategically.
- MP6. Attend to precision.
- MP7. Look for and make use of structure.
- MP8. Look for and express regularity in repeated reasoning.

MATHEMATICAL CONTENT

- 2.NBT.A.1. Understand that the three digits of a three-digit number represent amounts of hundreds, tens, and ones; e.g., 706 equals 7 hundreds, 0 tens, and 6 ones.
- 2.NBT.A.2. Count within 1,000; skip-count by 5s, 10s, and 100s.
- 2.NBT.A.3. Read and write numbers to 1,000 using base-ten numerals, number names, and expanded form.

Continued

Table 4.1. (*continued*)

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS

READING STANDARDS

- RI.2.1. Ask and answer such questions as *who, what, where, when, why,* and *how* to demonstrate understanding of key details in a text.
- RI.2.3. Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text.
- RI.2.7. Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.
- RI.2.8. Describe how reasons support specific points the author makes in a text.
- RI.2.9. Compare and contrast the most important points presented by two texts on the same topic.

WRITING STANDARDS

- W.2.1. Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., *because, and, also*) to connect opinion and reasons, and provide a concluding statement or section.
- W.2.2. Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.
- W.2.6. With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers.
- W.2.7. Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).
- W.2.8. Recall information from experiences or gather information from provided sources to answer a question.

SPEAKING AND LISTENING STANDARDS

- SL.2.1. Participate in collaborative conversations with diverse partners about *grade 2 topics and texts* with peers and adults in small and larger groups.
- SL.2.2. Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.
- SL.2.3. Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information, or deepen understanding of a topic or issue.

Continued

Table 4.1. (*continued*)

NATIONAL ASSOCIATION FOR THE EDUCATION OF YOUNG CHILDREN STANDARDS

- 2.G.02. Children are provided varied opportunities and materials to learn key content and principles of science.
- 2.G.03. Children are provided varied opportunities and materials that encourage them to use the five senses to observe, explore, and experiment with scientific phenomena.
- 2.G.04. Children are provided varied opportunities to use simple tools to observe objects and scientific phenomena.
- 2.G.05. Children are provided varied opportunities and materials to collect data and to represent and document their findings (e.g., through drawing or graphing).
- 2.G.06. Children are provided varied opportunities and materials that encourage them to think, question, and reason about observed and inferred phenomena.
- 2.G.07. Children are provided varied opportunities and materials that encourage them to discuss scientific concepts in everyday conversation.
- 2.G.08. Children are provided varied opportunities and materials that help them learn and use scientific terminology and vocabulary associated with the content areas.
- 2.H.02. All children have opportunities to access technology (e.g., tape recorders, microscopes, computers) that they can use.
- 2.H.03. Technology is used to extend learning within the classroom and integrate and enrich the curriculum.

FRAMEWORK FOR 21ST CENTURY LEARNING

- Interdisciplinary Themes; Learning and Innovation Skills; Information, Media, and Technology Skills; Life and Career Skills.

Table 4.2. Key Vocabulary for Lesson 1

Key Vocabulary	Definition
data	information collected by making observations, taking measurements, or asking questions
drought	a long period of dry weather with very little rainfall
earthquake	a sudden and dangerous shaking of the ground caused by movements in Earth's crust
environment	the conditions of the natural world, including living things, that make up our surroundings
equation	a mathematical expression that says two things are equal
evacuate	to move away from a dangerous area
evidence	factual information that can be used to support a belief or theory
flood	an overflow of a large amount of water over land that is normally dry
gravity	a force that pulls objects toward Earth
hurricane	a violent storm with very strong winds that forms over tropical waters; also called *cyclone* or *typhoon*, depending on where it occurs
landslide	the sliding of large amounts of soil and rocks down a mountain or cliff resulting from a storm
mathematical model	a way to describe something using numbers
meteorologist	a scientist who studies the atmosphere and the weather
model	a representation of something that is difficult to see or understand in everyday life
natural disaster	a natural hazard that results in harm to people or property
natural hazard	an event caused by nature that has the potential to harm people and the environment
percentage	a fraction that tells parts out of 100; uses the symbol %
physical model	a representation of an object using materials to create a larger or smaller version of the object
precipitation	water particles that fall from the sky to the ground in liquid or solid form, such as rain, snow, ice, and hail
prepare	to plan and get ready ahead of time

Continued

Table 4.2. (*continued*)

Key Vocabulary	Definition
prevent	to stop something from taking place
probability	the chance or likelihood that something will happen; can be measured with numbers (e.g., 10% chance) or expressed with words (e.g., possible, likely, unlikely, impossible, certain)
thundercloud	a cloud filled with electricity that produces thunder and lightning
thunderstorm	a storm with lightning and thunder, as well as heavy rain
tornado	violently spinning winds that resemble a funnel-shaped cloud
volcano	an opening in a mountain from which hot rocks, lava, and gas are pushed out
vortex	rotating liquid or air that tends to form a cone shape
weather	the daily conditions over a particular area that include temperature, precipitation, cloud cover, and air pressure
wildfire	a destructive fire that quickly spreads through woods, forests, and brush

TEACHER BACKGROUND INFORMATION

Second graders are able to make connections across multiple content areas (STEM and ELA), as well as the various developmental domains (physical, social and emotional, personality, cognitive, and language). Incorporating students' prior knowledge with developmentally appropriate instruction will enable them to make these connections. Throughout this module, you should support and facilitate the advancement of these content areas and developmental domains within each student. For information about how formative assessments can be used to connect students' prior experiences with classroom instruction, see the STEM Teaching Tools resource "Making Science Instruction Compelling for All Students: Using Cultural Formative Assessment to Build on Learner Interest and Experience" at *http://stemteachingtools.org/pd/sessionc*.

Natural Hazards

This module focuses on natural hazards and their effects on people and the environment. The terms natural hazard and natural disaster have different meanings to Earth scientists. Natural hazards are considered natural phenomena, such as tornadoes and hurricanes, that *have the potential* to affect people and property, while natural disasters are natural hazards that actually *do* affect people and property (see the U.S. Geological Survey's "EarthWord—Hazard" page at *www.usgs.gov/news/earthword-hazard* for more

information). This is a fine distinction that you need not introduce to students, but both terms are used in this module. For the purposes of this module, natural hazard is generally used to refer to the natural phenomena, while natural disaster is used to refer to the human experience of the event, although these terms can be used interchangeably for the purposes of classroom discussion.

Natural hazards are of two primary types: those associated with movements within Earth and those associated with weather events. Natural hazards caused by movements within Earth include earthquakes, volcanic eruptions, and tsunamis. Hazards of this type are difficult to predict, although new technologies are evolving to detect seismic activity. Natural hazards caused by weather events include tornadoes, hurricanes, blizzards, extremely heavy rains, drought, extreme heat, and extreme cold weather. Several types of natural disasters are supplementary to natural hazards, such as floods and landslides caused by heavy rains. For more information about various kinds of natural hazards, see the following websites:

- *www.earthtimes.org/encyclopaedia/environmental-issues/natural-disasters*
- *www.usgs.gov/science/science-explorer/Natural+Hazards*
- *https://earthquake.usgs.gov*
- *www.usgs.gov/natural-hazards/landslide-hazards*
- *https://volcanoes.usgs.gov/index.html*
- *www.nasa.gov/content/esd-natural-disasters*

Students discuss and explore a variety of natural hazards in this module; however, you may wish to place particular emphasis on one kind of hazard that is common in your geographic area and have students create their preparedness plans for this hazard. The American Red Cross provides an interactive map that identifies the most common natural disasters for each region of the United States at *www.redcross.org/get-help/how-to-prepare-for-emergencies/common-natural-disasters-across-us.html*.

This lesson focuses on natural hazards with weather-related causes, using tornadoes as an example. Most tornadoes originate from rotating thunderstorms and are rapidly rotating columns of air that reach from the thunderstorms to the ground. Wind speeds of the most extreme tornadoes have exceeded 300 miles per hour (mph). They can cause devastating damage to structures, uproot trees, and move vehicles and other property. Conditions that favor the formation of tornadoes include thunderstorms, conditions that lift moist air such as cold fronts, an unstable atmosphere (the temperature decreases rapidly with increasing height), and areas with strong winds that are turning in a clockwise direction.

Tornadoes are traditionally envisioned as funnel-shaped clouds that form a vortex, or spinning winds that are empty in the center. Tornadoes can be formed from one vortex or can contain multiple vortices. In this lesson, students will create a simple model of a vortex. This model is not intended to accurately model a tornado, but rather to allow students to explore the motion associated with tornado winds and observe that matter can move down through the center of a tornado.

Tornadoes are difficult to predict in advance since they form from a confluence of atmospheric factors; however, computer modeling can be used to identify where weather conditions might be favorable to tornado formation. The south-central portion of the United States, called "Tornado Alley," and Florida are areas with relatively high tornado frequencies. In Florida, tornadoes most frequently form in the late fall (October through December), while Tornado Alley experiences the most tornadoes in the late spring and early fall. Meteorologists at the National Oceanic and Atmospheric Administration's (NOAA's) Storm Prediction Center monitor the atmosphere for severe thunderstorms and conditions favorable to tornado formation. They may issue tornado *watches* based on these conditions. Tornado *warnings* are issued by local National Weather Service offices when a tornado has been sighted in an area or identified by weather radar.

Tornadoes' strengths are assigned ratings from 0 to 5 using the Enhanced Fujita Scale or EF Scale (introduced as a revision of the original Fujita Scale in 2007). This scale uses wind speed estimates and also takes into account observed damage based on variables such as types of structures. An EF0 tornado has wind speeds between 65 and 85 mph and only light damage, while an EF5 tornado has wind speeds over 200 mph with devastating damage. More information about tornadoes is available on the following websites:

- *www.ready.gov/tornadoes*
- *www.kids.nationalgeographic.com/explore/science/tornado/#tornado.jpg*
- *www.weatherwizkids.com/weather-tornado.htm*
- *www.nssl.noaa.gov/education/svrwx101/tornadoes/forecasting*

Optional Classroom Technology Tools

You might consider introducing mobile apps that allow tracking of natural hazard events and provide emergency preparedness information, such as the following:

- Apps available from the U.S. Red Cross, such as Monster Guard (geared toward emergency preparedness for children ages 7–11) and others for earthquakes, tornadoes, hurricanes, and floods

- Apps available for Apple mobile devices, such as Seismograph, Tremor Tracker, Dynamic Plates, and Volcanoes: Map, Alerts & Ash (note that these or similar apps are also be available for Android devices)

In addition, the LEGO Education WeDo platform provides a variety of activities related to natural hazards that you may wish to incorporate into the module if your school has these kits available. These include the following:

- *https://education.lego.com/en-us/lessons/wedo-2-science/robust-structures*
- *https://education.lego.com/en-us/lessons/wedo-2-science/prevent-flooding*
- *https://education.lego.com/en-us/lessons/wedo-2-computational-thinking/volcano-alert*
- *https://education.lego.com/en-us/lessons/wedo-2-science/drop-and-rescue*
- *https://education.lego.com/en-us/lessons/wedo-2-science/hazard-alarm*

Career Connections

You may wish to introduce careers associated with weather and natural disaster preparedness, such as the following (see Koehler, Bloom, and Milner 2015):

- Climatologist
- Ecologist
- Environmental engineer
- Geographer
- Materials engineer
- Meteorologist
- Urban planner

For more information about these and other careers, see the Bureau of Labor Statistics' *Occupational Outlook Handbook* at *www.bls.gov/ooh/home.htm*.

In this module, students are introduced to the idea that engineers work together in teams with those in other STEM careers to solve problems. Students experience working in teams and in pairs as they progress through a simple scientific process including predicting, observing, and explaining phenomena related to natural hazards in this lesson. This introduction to teamwork sets the stage for students' use of the engineering design process (EDP) later in the module.

Know, Learning, Evidence, Wonder, Scientific Principle (KLEWS) Charts

You will track student knowledge on Know, Learning, Evidence, Wonder, Scientific Principle (KLEWS) charts throughout this module. These charts are used to access and assess student prior knowledge, encourage students to think critically about the topic under discussion, and track student learning throughout the module. Using KLEWS charts challenges students to connect evidence and scientific principles with their learning. Be sure to list the topic at the top of each chart. The charts should consist of five columns, one for each KLEWS component. It may be helpful to post these charts in a prominent place in the classroom so that students can refer to them throughout the module. Students will write their personal ideas and reflections in their STEM Research Notebooks. For more information about KLEWS charts, see the January 2006 National Science Teaching Association *Web-News Digest* article "Evidence Helps the KWL get a KLEW" at *www.nsta.org/publications/news/story.aspx?id=51519* or the February 2015 *Science and Children* article "Methods and Strategies: KLEWS to Explanation-Building in Science" at *www.nsta.org/store/product_detail.aspx?id=10.2505/4/sc15_052_06_66.*

Interactive Read-Alouds

This module also uses interactive read-alouds to engage students, access their prior knowledge, develop their background knowledge, and introduce topical vocabulary. These read-alouds expose children to teacher-read literature that may be beyond their independent reading levels but is consistent with their listening level. Interactive read-alouds may incorporate a variety of techniques, and you can find helpful information regarding these techniques at the following websites:

- *www.readingrockets.org/article/repeated-interactive-read-alouds-preschool-and-kindergarten*
- *www.k5chalkbox.com/interactive-read-aloud.html*
- *www.readwritethink.org/professional-development/strategy-guides/teacher-read-aloud-that-30799.html*

In general, interactive read-alouds provide opportunities for students to share prior knowledge and experiences, interact with the text and concepts introduced therein, launch conversations about the topics introduced, construct meaning, make predictions, and draw comparisons. You may wish to mark places within the texts to pause and ask students to share their experiences, predictions, or other ideas. Each reading experience should focus on an ongoing interaction between students and the text, making time to do the following:

- Allow students to share personal stories throughout the reading

- Ask students to predict throughout the story
- Allow students to add new ideas from the book to the KLEWS chart and their STEM Research Notebooks
- Allow students to add new words from the book to the vocabulary chart and their STEM Research Notebooks

The materials list for each lesson includes the books for interactive read-alouds that you will use in that lesson. A list of suggested books for additional reading can be found at the end of this chapter (see p. 112).

Working With Large Numbers

In this module's mathematics and social studies connections, students consider numerical data associated with natural hazards. Some of these data, such as homes without power, people evacuated, and financial costs of rebuilding and repairs, may be expressed in large numbers, including hundreds of thousands and millions. You should therefore be prepared to discuss place values and large numbers with students, and you may wish to prepare a chart of place values to display in the classroom. The following websites provide ideas and additional resources for introducing large numbers to early elementary students:

- *www.mathcoachscorner.com/2012/08/place-value-reading-large-numbers*
- *www.mathgeekmama.com/books-teach-place-value-large-numbers*

COMMON MISCONCEPTIONS

Students will have various types of prior knowledge about the concepts introduced in this lesson. Table 4.3 outlines some common misconceptions students may have concerning these concepts. Because of the breadth of students' experiences, it is not possible to anticipate every misconception that students may bring as they approach this lesson. Incorrect or inaccurate prior understanding of concepts can influence student learning in the future, however, so it is important to be alert to misconceptions such as those presented in the table.

Table 4.3. Common Misconceptions About the Concepts in Lesson 1

Topic	Student Misconception	Explanation
Natural hazards	Tornadoes only occur in the Midwest.	Although tornadoes are most likely to occur in Midwestern states, they can occur anywhere.
	A small amount of water from flooding is not dangerous.	As little as 6 inches of moving water can knock people off their feet, and about 2 feet of water will cause a car to float.
	There is nothing we can do to protect ourselves from natural hazards.	While we cannot prevent hazards such as tornadoes, hurricanes, earthquakes, and volcanic eruptions, we can take measures to protect human life and property in areas likely to be affected by those hazards. These include designing homes and buildings to withstand hurricanes' high winds and earthquake tremors, providing basements or safe rooms where people can go during tornado warnings, and evacuating people from areas in the path of a hurricane.
Weather	We can predict weather in the long term by looking at animals' behaviors and their coats.	We cannot predict weather by animals' behaviors and the thickness of their fur. Weather can be predicted only by observing factors in the atmosphere, so it is difficult to make long-range weather predictions.
	Wind is caused by cold weather.	Wind is caused by uneven heating of Earth's surface and pockets of air with different amounts of heat.
	Clouds block or slow down wind.	Clouds are large collections of tiny water droplets or ice crystals that are light enough to float in the air; they do not block the wind but can be moved by the wind.
	Snow and ice create cold temperatures.	Snow and ice are caused by cold temperatures, which freeze moisture in the atmosphere.

PREPARATION FOR LESSON 1

Review the Teacher Background Information section (p. 51), assemble the materials for the lesson, duplicate the student handouts, and preview the videos recommended in the Learning Components section below. Present students with their STEM Research Notebooks and explain how they will be used (see p. 24). Templates for the STEM Research Notebook are provided in Appendix A, and an Observation, STEM Research Notebook, and Participation Rubric is provided in Appendix B.

You may wish to use the template for STEM Research Notebook Entry #5 throughout the module for students to record definitions and draw illustrations of key vocabulary words. The template provides space for three words. If you plan to introduce more than five vocabulary words in a lesson, you should make multiple copies of the template for each student.

Identify a natural hazard that has affected an area somewhere in the world recently. If possible, you may wish to choose a natural hazard that has affected your geographic area. The class will investigate this event and track its impacts throughout the module. You should have on hand the location of the event, some basic facts, and some pictures to share with students. You should also have available an estimate of the number of people affected by the disaster and some other numerical facts (e.g., inches of rain, days or hours in which the event occurred, homes without power, people evacuated, estimated costs to clean up, estimated lost wages). Create a written narrative about the event appropriate to your students' reading level, including numerical facts about the event within the text. Duplicate this narrative for each student. See the questions on STEM Research Notebook Entry #2 for additional information you should research beforehand and be prepared to discuss with the class.

For the mathematics connection (see p. 64), have a copy of a printed weather report or a video of a weather report that includes varying probabilities for precipitation on multiple days.

LEARNING COMPONENTS

Introductory Activity/Engagement

Connection to the Challenge: Begin each day of this lesson by directing students' attention to the module challenge, the Natural Hazard Preparedness Challenge:

> *Your town's leaders want to be sure that people will be safe in case a natural hazard should strike your town. They have asked your class to create preparedness plans for natural hazards that will keep people safe during these events. You and your team are challenged to create a plan for the community for one natural hazard and an advertisement that lets people know about your plan.*

Tell students that they will learn about different kinds of natural hazards and how they can affect people as well as animals. To do this, they need to learn about the kinds of natural hazards that occur around the world and in your area and about local animal habitats and homes. Hold a brief class discussion of how students' learning in the previous days' lessons contributed to their ability to complete the challenge. You may wish to create a class list of key ideas on chart paper.

Science Class and ELA Connection: Introduce the module by holding a class discussion about natural hazards. Put chart paper on the wall and keep it up throughout the module for students to refer to. Through whole-class discussion, have students share their conceptions of what natural hazards are and what the influences of natural hazards are. Following agreed-upon rules for discussions, ask students the following questions:

- What are natural hazards?
- Are there different types of natural hazards?
- What types of natural hazards are there?
- What causes natural hazards?
- Can people make or cause natural hazards?
- Where and when have you seen natural hazards?

As students share their ideas, chart the responses in the Know column of a KLEWS chart. Then, ask students what questions they have about the natural hazards, recording these questions in the Wonder column.

Introduce students to the STEM Research Notebooks they will use throughout the module. Explain to students that scientists and people in other STEM careers use research notebooks to track their work. Then, show a video about natural hazards, such as "Natural Disasters" at *www.youtube.com/watch?v=_smJ13x90oM,* and hold a class discussion about the various natural hazards featured in the video.

STEM Research Notebook Entry #1

Have students document their own personal experiences with natural hazards or memorable weather events in their STEM Research Notebooks, using both words and pictures.

Social Studies and Mathematics Connections: Have students name natural hazards and create a class list. Ask students if they think some natural hazards occur more often in certain places. Students should understand that natural hazards often occur where there are specific landforms (e.g., volcanoes and earthquakes) or weather patterns (e.g., tornadoes occur most often in the central United States, and hurricanes most frequently affect areas along ocean coastlines). Help students locate on the map or globe the regions

throughout the United States where these natural hazards take place. Be sure to emphasize that natural hazards can occur at other places around the world (e.g., tsunamis caused by underwater earthquakes in Japan in 2011 and in Indonesia in 2018). Explain that the same kind of storms may be called *hurricanes, cyclones,* or *typhoons,* depending on where in the world they occur.

Introduce the class to a natural hazard that was in the news recently. Help students identify the location where the natural hazard occurred on the map or globe. Have three or four students provide estimates of the number of people affected, and work as a class to find an average of students' estimates. Then, provide information about the actual number of people affected. Work as a class to find the difference between the actual number of people affected and students' estimates.

Throughout the module, you should discuss with the class the impacts this natural disaster event is having on the community in which it occurred (e.g., economic, business, health, and environmental impacts). Discuss information about the disaster (see STEM Research Notebook Entry #2).

STEM Research Notebook Entry #2

Have students record this information about a current natural disaster in their notebooks.

Activity/Exploration

Science Class and ELA Connection: Make a list on the board of various types of natural hazards (be sure to include, at a minimum, tornadoes, hurricanes, volcanoes, earthquakes, and floods). Next, ask students to identify what causes each type of disaster (i.e., weather or movement within Earth's surface) and record this on the list.

STEM Research Notebook Entry #3

Have students complete a T-chart classifying natural disasters according to their causes. The column headers of the chart are the causes (weather and movements within Earth), and students should enter each of the natural hazards listed on the board under the appropriate cause.

Next, ask students how thunderstorms, tornadoes, and hurricanes are the same and different, documenting their ideas on a KLEWS chart. Then, conduct an interactive read-aloud of *Violent Weather: Thunderstorms, Tornadoes, and Hurricanes,* by Andrew Collins.

STEM Research Notebook Entry #4

After the read-aloud, ask students to reflect on what they learned about the causes of thunderstorms, tornadoes, and hurricanes in their STEM Research Notebooks. Students

should also document how these weather events are alike and different using both words and pictures.

Begin a class vocabulary chart using vocabulary from the interactive read-aloud. Use pictures to illustrate the vocabulary, and post the chart on the classroom wall in a location where it can be easily referenced. You will add to this chart throughout the module.

STEM Research Notebook Entry #5

Have students add the vocabulary words and their definitions to their STEM Research Notebooks, using both words and pictures.

Next, show students a video about tornadoes and their causes, such as "Tornado Facts for Kids!" at *www.youtube.com/watch?v=vH4YT9secVw.* Hold a class discussion about why tornadoes are destructive, emphasizing that winds rotate to form a *vortex* that reaches down from the sky to the ground and moves at very fast speeds. Ask students to share their ideas about what happens to objects in the path of a tornado. Explain that the winds move so fast that objects in a tornado's path can be taken up inside the tornado.

Introduce students to the Vortex Bottle Investigation and the Predict, Observe, Explain process. Students will create STEM Research Notebook entries for each phase of this process. You should also track students' predictions, observations, and explanations on a class chart. Ask students to share their ideas about what a model is, creating a class list. Introduce the idea that a model is a way to represent something that is hard to see or understand in everyday life. Students should understand that models are often smaller representations of larger objects, like model airplanes, but may also be larger representations of things that are too small to see, like the cells that make up the human body. Using students' ideas, formulate a class definition for the term *model* that reflects that a model is a way to show important features of something that is difficult to see in everyday life. Have students brainstorm types of models they have experienced (e.g., model cars, models of the solar system, models of volcanoes erupting). Explain to students that these are called *physical models*, or models that are smaller or larger versions of something else. Have students brainstorm ideas about the benefits of using models (e.g., lets us see and touch things we normally can't). Next, ask students to share their ideas of ways that models are like and unlike the actual object, recording their ideas on a T-chart. Tell students that they are going to create models of the way the wind moves in a tornado. Ask students to brainstorm ideas about how they could do this. After students have shared their ideas, tell them that they will create conditions similar to tornado winds using water in a bottle in the Vortex Bottle Investigation. Tell students that they will make the water move in the same way that tornado winds move. Ask students to describe how tornado winds move, reminding them to use the term *vortex.*

Tell students that they will work in pairs to create a vortex in a bottle and discover what happens to objects in the vortex. Each pair should have all the supplies needed to build a vortex bottle at their table or area. First, however, hold a class discussion, having students predict what will happen by answering the following questions:

- What is a vortex?
- What makes a vortex in nature?
- What are the effects of a wind vortex like a tornado on the environment?
- What will happen to debris in your vortex bottle when you create the vortex?
- What will happen to debris in your vortex bottle after the vortex stops?

Document their predictions on a Predict, Observe, Explain (POE) chart.

STEM Research Notebook Entry #6

Have students write their predictions of what will occur in their vortex bottles during and after the vortex in their STEM Research Notebooks.

After students have completed their predictions, have student pairs conduct the Vortex Bottle Investigation.

Vortex Bottle Investigation

Direct students to do the following:

1. Fill a clear 2 liter plastic bottle about ¾ full with water.
2. Clean up any spilled water with the paper towels.
3. Add a couple of drops of dishwashing liquid.
4. Add a small bit of "debris" (glitter).
5. Put the cap on the bottle tightly.
6. Turn the bottle upside down and spin the bottle in a circular motion.
7. Continue spinning the bottle for about 30 seconds and make observations.
8. Sketch the vortex and the position of the glitter in the chart provided in STEM Research Notebook Entry #7.
9. Allow the water to stop spinning.

10. Sketch the water and the position of the glitter in STEM Research Notebook Entry #7.

Ask students to share their observations of what happened to the debris in the vortex bottle. Document observations on the POE chart.

STEM Research Notebook Entry #7

Students should record their vortex bottle observations, using both words and pictures, as indicated in the previous steps.

Mathematics and Social Studies Connections: Ask students to list ideas of things related to natural hazards that numbers could describe (e.g., inches of rain, speed of wind, number of people affected, number of homes without power, number of hours or days the natural hazard was active). Next, conduct an interactive read-aloud of pages 4–21 of *Hurricanes (Real World Math: Natural Disasters series),* by Barbara A. Somervill.

STEM Research Notebook Entry #8

After reading the book, have students document what they learned about how they can use mathematics to understand hurricanes in their STEM Research Notebooks, using both words and pictures.

Explanation

Science Class: Have students explain their observations from the Vortex Bottle Investigation first as a class, and then by recording their explanations in their STEM Research Notebooks. As a class, revisit student predictions about the vortex bottles, and ask students if their predictions about what would happen to the glitter were accurate. (They likely observed that the glitter was drawn from the surface of the water into the vortex as it was spinning, and then after the water settled, the glitter sank to the bottom.) Hold a class discussion about how the vortex held the glitter in a compact area while it was spinning. Ask students to consider how objects that are lifted up in a tornado wind vortex would behave. Introduce the idea that when they swirled their bottles, an empty space was created in the center of the water that drew down the surface water with the glitter in it. Ask students if they know what force pulled their glitter downward, and introduce the term *gravity.*

STEM Research Notebook Entry #9

Have students record their explanations of the motion of the glitter in their STEM Research Notebooks.

Remind students that the vortex bottles were models of how winds move in a tornado and that models are not exactly like the thing that they represent. Ask students to share their ideas about how the vortex bottles were like and unlike the winds in a tornado, recording student ideas on a T-chart. Next, ask students to share their ideas about how they could make their models more like an actual tornado, recording students' ideas on chart paper.

Mathematics Connection: Ask students to share their ideas about how they know what the weather will be like tomorrow. Introduce the idea that weather reports they see in the news are based on a science called *meteorology* that uses mathematics to express the chance that the weather will behave in a certain way. Remind students of the discussion they had about models, and introduce the idea that models can also use numbers and equations to show how things work and to make predictions. Introduce the term *mathematical model*, and tell students that meteorologists use mathematical models to predict how the weather will behave. They formulate equations based on conditions in the atmosphere and how the weather has behaved in the past and use these to predict future weather.

Show students a local weather report that includes probabilities of precipitation. Ask them to identify the days when precipitation is most likely and least likely and how they know this. Explain to students that scientists study weather patterns such as air movements and air temperatures to determine whether the conditions are present for rain, snow, or other weather events. Ask students if the weather report is always correct (no). Explain that this is because meteorologists can make predictions based only on the information they have and on how they know the weather has behaved in the past. Since they cannot be sure that a weather event will happen, they use percentages to express the chance, or *probability*, of a weather event occurring. Students should understand that the higher the percentage, the more confident the meteorologist feels about his or her prediction.

Ask students to share what they know and what they want to know about weather reporting and probabilities, recording student ideas on a KLEWS chart. Then, conduct an interactive read-aloud of *That's a Possibility!: A Book About What Might Happen*, by Bruce Goldstone.

STEM Research Notebook Entry #10

After reading the book, have students document what they learned about probabilities in their STEM Research Notebooks, using both words and pictures.

ELA Connection: Remind students that some of the natural hazards they have discussed are related to the weather, including precipitation, such as rain and snow, that falls from the sky. Tell students that they are going to read together a story about a place where

food, instead of rain and snow, fall from the sky. Introduce the concept of a tall tale as a story that includes elements that are unbelievable and impossible but that are told as if they could actually happen. Introduce *Cloudy With a Chance of Meatballs,* by Judi Barrett, as a tall tale, and ask students to listen for evidence of a natural hazard as you read the book. Then, conduct an interactive read-aloud. After the read-aloud, ask students to share their ideas about what the natural hazard was in the story (too much food falling from the sky) and how this event is like and unlike an actual natural hazard such as a heavy rainstorm or blizzard. Record student responses on a class T-chart.

Introduce the idea to students that stories have different parts. Have students offer their ideas about what the parts of a story are, creating a class list. Guide students to understand that all stories have some basic parts: beginning, middle, end, characters, setting, and what the story is about (plot). Next, create a two-column chart with columns labeled "Basic Parts of Stories" and "Parts of the Story in *Cloudy With a Chance of Meatballs.*" Create a row for each basic story part, and work together as a class to complete the chart.

Social Studies Connection: Remind students of the earlier class discussion when they decided that different kinds of natural hazards were more likely to happen in different places (see p. 59). Point out the places on the map or globe where hazards such as tornadoes, earthquakes, and volcanoes are more likely to happen. Hold a class discussion about being prepared for natural hazards, asking students questions such as the following:

- How would life be the same and different in regions that have more natural hazards compared with regions that do not?
- What are the pros and cons of living in different regions that have different natural hazards?
- How do communities prepare for natural hazards?
- What financial costs do you think natural hazards have for local communities?

Document students' ideas, thoughts, and responses on a KLEWS chart.

Elaboration/Application of Knowledge

Science Class and Social Studies Connection: Hold a class discussion about the possible effects of large amounts of rain, asking students for their ideas. Create a class list. Introduce the idea that a flood occurs when an unusually large amount of rain falls and collects in low-lying area or causes rivers and creeks to overflow. Have students share their personal experiences with large amounts of rain or floods. Ask students what they know about floods and how people can be prepared for a flood and what they wonder about these topics, recording student responses on a KLEWS chart. Conduct an

interactive read-aloud of *Flood Warning (Let's-Read-and-Find-Out Science 2),* by Katharine Kenah. After the reading, ask students what they learned about floods and preparing for floods, adding to the KLEWS chart. Next, ask students how they learned about floods and flood preparation, prompting students to understand that they learned based on information provided in the book. Introduce the term *evidence* as knowledge that we use to support our beliefs. As a class, review the book to find points in the text that were used as evidence to add to the "E" column of the KLEWS chart.

Assess student learning in this lesson by asking students to do the following:

- Identify four natural hazards, using words and pictures
- Identify the causes of these four natural hazards
- Choose two of the natural hazards and describe two ways each of these natural hazards could affect people in the community where they happen
- Identify two types of models and give examples of each, using words and pictures

ELA Connection: Have students write and illustrate their own tall tales related to the weather by responding to the following prompt:

> *I woke up one Saturday morning and heard wind outside. I looked out my window and saw …*

Distribute the Creative Writing Rubric (p. 163) and review it with the class. Hand out blank sheets of paper, and have students brainstorm their story ideas using both words and pictures. Once each student has decided on an idea, have students complete the chart provided in STEM Research Notebook Entry #11 to plan their stories.

STEM Research Notebook Entry #11

Have students plan their Weather Tall Tales by completing the chart with the basic parts of the story and the corresponding parts of their own stories. In the "Basic Parts of a Story" column, be sure that students list the following:

- Setting
- Characters
- Plot
- Beginning
- Middle
- End

After students have created their plans, give each student three sheets of lined paper on which to write their stories. Then, after students have completed writing their stories, give each student two sheets of plain white paper on which to draw pictures for their stories. When they are done, have them assemble and staple the pages to create their own books. Have students share their stories with a parent, caregiver, sibling, or friend.

Mathematics Connection: Hand out the narrative you created for the current or recent natural hazard (see Preparation for Lesson 1, p. 58). Have students read the narrative, and ask them to share their observations about how numbers were used. Work as a class to decide how the event could be described using numbers. Introduce the term *data* to the class, and tell them that often numerical data are represented in tables, charts, or graphs so that the data are easier to understand. Create a class table listing relevant items in one column (e.g., inches of rain, number of homes without power, number of people evacuated, lost wages) and the corresponding numerical data in the other. Ask students to share their ideas about whether this is easier or more difficult to understand than the narrative they read, whether there is important information in the narrative that is not included in the table, and how the narrative and the table could be used together to help people understand the impacts of the natural hazard.

Evaluation/Assessment

Students may be assessed on the following performance tasks and other measures listed.

Performance Tasks

- Vortex Bottle Investigation
- Lesson assessment
- Weather Tall Tale (see Creative Writing Rubric, p. 163)

Other Measures (see rubric on p. 162)

- Teacher observations
- STEM Research Notebook entries
- Participation in teams during investigations

INTERNET RESOURCES

Formative assessment

- *http://stemteachingtools.org/pd/sessionc*

Natural hazard information

- *www.usgs.gov/news/earthword-hazard*

- *www.earthtimes.org/encyclopaedia/environmental-issues/natural-disasters*
- *www.usgs.gov/science/science-explorer/Natural+Hazards*
- *https://earthquake.usgs.gov*
- *www.usgs.gov/natural-hazards/landslide-hazards*
- *https://volcanoes.usgs.gov/index.html*
- *www.nasa.gov/content/esd-natural-disasters*

Locations of natural hazards

- *www.redcross.org/get-help/how-to-prepare-for-emergencies/common-natural-disasters-across-us.html*

Tornadoes

- *www.ready.gov/tornadoes*
- *www.kids.nationalgeographic.com/explore/science/tornado/#tornado.jpg*
- *www.weatherwizkids.com/weather-tornado.htm*
- *www.nssl.noaa.gov/education/svrwx101/tornadoes/forecasting*

LEGO Education WeDo resources

- *https://education.lego.com/en-us/lessons/wedo-2-science/robust-structures*
- *https://education.lego.com/en-us/lessons/wedo-2-science/prevent-flooding*
- *https://education.lego.com/en-us/lessons/wedo-2-computational-thinking/volcano-alert*
- *https://education.lego.com/en-us/lessons/wedo-2-science/drop-and-rescue*
- *https://education.lego.com/en-us/lessons/wedo-2-science/hazard-alarm*

Career information

- *www.bls.gov/ooh/home.htm*

KLEWS charts

- *www.nsta.org/publications/news/story.aspx?id=51519*
- *www.nsta.org/store/product_detail.aspx?id=10.2505/4/sc15_052_06_66*

Interactive read-alouds

- *www.readingrockets.org/article/repeated-interactive-read-alouds-preschool-and-kindergarten*

- *www.k5chalkbox.com/interactive-read-aloud.html*
- *www.readwritethink.org/professional-development/strategy-guides/teacher-read-aloud-that-30799.html*

"Natural Hazards" video

- *www.youtube.com/watch?v=_smJ13x90oM*

"Tornado Facts for Kids!" video

- *www.youtube.com/watch?v=vH4YT9secVw*

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Page numbers printed in **boldface type** indicate tables, figures, or handouts.

Grade 2

STEM Road Map for Elementary School

Natural Hazards

What if you could challenge your second graders to help communities prepare for disasters ranging from floods and wildfires to earthquakes and hurricanes? With this volume in the *STEM Road Map Curriculum Series,* you can!

Natural Hazards outlines a journey that will steer your students toward authentic problem solving while grounding them in integrated STEM disciplines. Like the other volumes in the series, this book is designed to meet the growing need to infuse real-world learning into K–12 classrooms.

This interdisciplinary module uses project- and problem-based learning to help young children explore cause and effect. Working in teams, your second graders will draw on science, English language arts, mathematics, social studies, and the engineering design process to do the following:

- Identify various natural hazards, their basic causes, and how they affect people, animals, and communities.
- Model natural hazards.
- Identify features of structures designed to withstand earthquakes and then construct models of those structures.
- Learn about predicting weather, including measuring, calculating, and evaluating numbers involved in probabilities.
- Create their own "Weather Tall Tales."
- Identify ways that people and communities can prepare for natural hazards and then communicate about the hazards to a target audience.

The *STEM Road Map Curriculum Series* is anchored in the *Next Generation Science Standards,* the *Common Core State Standards,* and the Framework for 21st Century Learning. In-depth and flexible, *Natural Hazards* can be used as a whole unit or in part to meet the needs of districts, schools, and teachers who are charting a course toward an integrated STEM approach.

Grade 2

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