Investigating Environmental Changes

STEM Road Map for Elementary School

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

NSTA press
National Science Teachers Association

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Grade 2

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NSTApress
National Science Teachers Association
Arlington, Virginia

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www.nsta.org/store
For customer service inquiries, please call 800-277-5300.

22 21 20 19 4 3 2 1

Library of Congress Cataloging-in-Publication Data
Names: Johnson, Carla C., 1969- editor. | National Science Teachers Association.
Title: Investigating environmental changes, Grade 2 : STEM road map for elementary school / edited by Carla C. Johnson, Janet B. Walton, and Erin Peters-Burton.
Description: Arlington, VA : National Science Teachers Association, [2019] | Series: STEM road map curriculum series | Includes bibliographical references and index.
Identifiers: LCCN 2018039533 (print) | LCCN 2018041239 (ebook) | ISBN 9781681405353 (e-book) | ISBN 9781681405346 (print)
Subjects: LCSH: Environmental sciences--Study and teaching (Elementary)--United States. | Environmental education--United States. | Earth sciences--Study and teaching (Elementary)--United States. | Ecology--Study and teaching (Elementary)--United States.
Classification: LCC GE80 (ebook) | LCC GE80 .I58 2019 (print) | DDC 372.35/044--dc23
LC record available at *https://lccn.loc.gov/2018039533*

The *Next Generation Science Standards* ("*NGSS*") were developed by twenty-six states, in collaboration with the National Research Council, the National Science Teachers Association and the American Association for the Advancement of Science in a process managed by Achieve, Inc. For more information go to *www.nextgenscience.org.*

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ACKNOWLEDGMENTS

This module was developed as a part of the STEM Road Map project (Carla C. Johnson, principal investigator). The Purdue University College of Education, General Motors, and other sources provided funding for this project.

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INVESTIGATING ENVIRONMENTAL CHANGES MODULE OVERVIEW

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

THEME: The Represented World

LEAD DISCIPLINES: English Language Arts, Science, and Mathematics

MODULE SUMMARY

In this module, students explore changes in the natural environment, focusing on ways to observe and measure these changes. Students are challenged to design and build an outdoor STEM classroom that they and other students at their school will use to observe phenomena such as plant and animal life cycles and the movement of the Earth around the Sun. Students create a proposal for the outdoor classroom and use the engineering design process (EDP) to create the space. Students also devise a data collection plan to observe and analyze changes in the outdoor classroom over time (adapted from Koehler, Bloom, and Milner 2015).

ESTABLISHED GOALS AND OBJECTIVES

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

- Demonstrate conceptual awareness of changes in the environment over time due to natural and human-created causes
- Identify and describe various changes in the natural environment, including plant and animal life cycles, associated with the Earth's movement around the Sun
- Use technology to gather research information and communicate

- Identify technological advances and tools that scientists use to learn about changes over time
- Describe and apply the EDP
- Use persuasive language to create a proposal for an outdoor STEM classroom
- Create works of fiction incorporating the outdoor STEM classroom
- Understand local weather patterns and make connections among weather patterns, the seasons, and plant life cycles
- Understand the influence of recycling of packaging materials used in consumer products on the environment
- Identify and demonstrate recycling practices, including sorting materials and tracking amounts of materials recycled
- Explain concepts and analyze data they collect in the context of the outdoor STEM classroom

CHALLENGE OR PROBLEM FOR STUDENTS TO SOLVE: OUTDOOR STEM CLASSROOM DESIGN CHALLENGE

In this module, the class adopts a plot of land in their schoolyard to create an outdoor STEM classroom. This outdoor classroom will include a life science area (a butterfly garden and a birdbath) and an Earth science area (sundial). The class will plan for optimal land use and responsible water consumption. Students will be challenged to design, create, and maintain the outdoor classroom and will observe changes over time in the outdoor classroom. Students will describe the changes and devise ways to collect, measure, and analyze data in their outdoor STEM classroom.

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 (p. 147). 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 this 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 1–22) and templates for each notebook entry are included in Appendix A (p. 117).

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

Launch the module by holding a class discussion about changes in the environment, asking students the following:

- What changes have you observed in the environment?
- Over what period of time did those changes occur?
- What do you think causes these changes?

Show a video that uses time lapse photography to allow students to observe changes on Earth from a large-scale, long-term perspective. An example is the National Geographic video "Breathtaking Time-Lapse Video of Earth From Space" at *www.youtube.com/watch?v=TGBQazOQfoE.* Tell students that as part of their challenge in this module, they will design and build an outdoor STEM classroom for their class and other students in their school to use to observe and learn about environmental changes over time.

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 Knowledge
Science • Understand cause and effect	*Science* • Determine how human activities can cause changes in the environment. • Determine the Earth's movement around the Sun causes the changes they observe in the outdoor STEM classroom.	*Science* • Provide students with content via books, videos, songs, and computer programs to help students understand the impact of human activity on the environment and the effects of the Earth's movement around the Sun on the natural world. • Read aloud picture books to class and have students identify cause and effect sequences.
Mathematics • Number sense	*Mathematics* • Devise ways to measure observations. • Measure phenomena in the outdoor STEM classroom. • Calculate differences in measurements of phenomena over time.	*Mathematics* • Provide examples of ways to measure observed phenomena, such as time of day, plant growth, and amounts of rainfall. • Model measurement techniques using standard and nonstandard units of measurement. • Read aloud nonfiction texts about measurement to class. • 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 observations using pictures and words • Ask and respond to questions	*Language and Inquiry Skills* • Make and confirm or reject predictions. • Share thought processes through notebooking, asking and responding to questions, and use of the engineering design process.	*Language and Inquiry Skills* • As a class, make predictions when reading fictional texts. • As a class, make predictions about observed natural phenomena (e.g., precipitation, plant growth). • Model the process of using information and prior knowledge to make predictions. • Provide samples of notebook entries.

Continued

Table 3.1. (*continued*)

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Knowledge
Speaking and Listening • Participate in group discussions	*Speaking and Listening* • Engage in collaborative group discussions in the development of the outdoor STEM classroom and devising a data collection plan.	*Speaking and Listening* • Model speaking and listening skills. • Create a class list of good listening and good speaking practices. • Read aloud 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 illustrates some of the activities in the Investigating Environmental Changes 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	Example From Investigating Environmental Changes Module	Lesson Number and Learning Component
BEFORE LEARNING		
Motivates students	Students observe changes on Earth from a large-scale, long-term perspective by viewing a time lapse video of the Earth.	Lesson 1, Introductory Activity/Engagement
Evokes prior learning	Students are asked during a class discussion about their observations of changing in the environment, when the changes occurred, and what they think caused the changes.	Lesson 1, Introductory Activity/Engagement
DURING LEARNING		
Focuses on important features	Teacher conducts the interactive read-aloud of *Rosie Revere, Engineer* by Andrea Beaty. Students document what they learned about engineers in their STEM Research Notebooks after the interactive read-aloud.	Lesson 2, Activity/ Exploration
Helps students monitor their progress	Teacher holds a class discussion about how each of the steps of the engineering design process (EDP) was included in the book. The class uses the EDP to create a design for a birdbath for the outdoor STEM classroom.	Lesson 2, Activity/ Exploration
AFTER LEARNING		
Evaluates learning	Students plan, build, and create a maintenance plan for an outdoor STEM classroom. Teacher uses the Observation/STEM Research Notebook/Participation Rubric to evaluate student learning.	Lesson 3, Elaboration/ Application of Knowledge
Takes account of what worked and what did not work	Students use evidence from the observation journal the class designed to consider improvements to their outdoor STEM classroom.	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 gardening 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 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 through inquiry and design activities. In addition, students learn in a variety of ways, including through doing inquiry activities, journaling, reading a variety of 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 presentations, and modeling.

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 and mathematics is largely collaborative throughout the module, this strategy may be most appropriate for social studies or ELA activities.

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. Recount or describe key ideas or details from a text read-aloud or information presented orally or through other media.
- Standard 2: The language of Language Arts. Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in

coherent sentences. Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure. Write narratives in which they recount two or more appropriately sequenced events, include some details regarding what happened, use temporal words to signal event order, and provide some sense of closure.

- Standard 3: The language of Mathematics. Order three objects by length; compare the lengths of two objects indirectly by using a third object. Analyze text of word problems.
- Standard 4: The language of Science. Remember the changes in life cycles.
- Standard 5: The language of Social Studies. Identify the main topic of a multi-paragraph text as well as the focus of specific paragraphs within the text. Describe the connection between a series of historical events, scientific ideas or concepts, or steps.

SAFETY CONSIDERATIONS FOR THE ACTIVITIES IN THIS MODULE

Science activities in this module focus on growing plants from seeds, creating a sundial, and recycling. Students should use caution when handling scissors, bottles, and cans. Sharp points or edges can cut or puncture skin, and bottles can break if not handled carefully. Also caution students not to eat seeds, as they may be treated with toxic chemicals. When outside, avoid exposure to poisonous plants, harmful insects, broken glass, and other hazards. Be particularly sensitive to students who may have allergies to pollen or insect bites and other health issues. Check with parents and the school nurse before initiating activities to determine degree of issue and response required. Always have students wash hands with soap and water after completing these activities. For more general safety guidelines, see the Safety in STEM section in Chapter 2 (p. 18).

This module focuses on environmental changes over time with an emphasis on plant growth and creating an outdoor STEM classroom using the EDP. Students will work with a variety of materials as they explore environmental changes and use the EDP to create the outdoor classroom. You should discuss appropriate use of materials with students at the start of each activity.

DESIRED OUTCOMES AND MONITORING SUCCESS

The desired outcomes for this module are outlined in Table 3.3 (p. 32), 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 and individual lessons.

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

Desired Outcomes	Evidence of Success	
	Performance Tasks	Other Measures
Students understand and can demonstrate their knowledge about how even small areas undergo observable natural changes. Students collect and analyze data about these changes and create works of fiction that incorporate elements of the outdoor STEM classroom.	• Student teams plan, build, and maintain an outdoor STEM classroom to explore environmental changes over time. • Students each maintain a STEM Research Notebook with what they want to know, responses to questions, and observations. • Students create works of fiction incorporating elements of the outdoor STEM classroom that demonstrate an understanding of basic story structure, dialogue, and the role of illustrations in works of fiction. • Working as a class, students design an observation journal to be used during the rest of the school year.	Students are assessed using the Observation, STEM Research Notebook, and Participation Rubric and the Creative Writing Rubric.

ASSESSMENT PLAN OVERVIEW AND MAP

Table 3.4 provides an overview of the major group and individual *products* and *deliverables*, or things that student teams will produce in this module, that constitute the assessment for this module. See Table 3.5 for a full assessment map of formative and summative assessments in this module.

Table 3.4. Major Products and Deliverables in Lead Disciplines for Groups and Individuals

Lesson	Major Group Products and Deliverables	Major Individual Products and Deliverables
1	• Eroding Earth investigation	• STEM Research Notebook entries 1–9 • Lesson Assessment questions
2	• Team research for outdoor STEM classroom	• STEM Research Notebook entries 10–18 • Lesson Assessment questions
3	• Construction of outdoor STEM classroom • Creation of observation journal	• STEM Research Notebook entries 19–22 • Lesson Assessment questions • Works of fiction incorporating outdoor STEM classroom

Table 3.5. Assessment Map for Investigating Environmental Changes Module

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	STEM Research Notebook *entries*	Individual	Formative	• Understand the environment changes over time. • Understand there are different reasons for environmental changes over time (natural and human created).
1	Participation in class weather observations and analysis *Observation, STEM Research Notebook, and Participation Rubric*	Individual	Formative	• Chart, graph, identify, describe, and analyze patterns of local weather to make connections among daily weather, the seasons, and plant life cycles.
1	Participation in class recycling *Observation, STEM Research Notebook, and Participation Rubric*	Individual	Formative	• Sort recyclables each day. Measure (e.g., number of items, volume of items, or weight), chart, and graph daily recycling and compare daily tallies.
1	Proposal to the principal seeking permission to build an outdoor STEM classroom *Observation, STEM Research Notebook, and Participation Rubric*	Individual	Formative	• Write a proposal to the school principal seeking permission to build an outdoor STEM classroom that will foster the students' engineering, technology, and scientific skills and provide the opportunity to conduct scientific inquiries.
1	Eroding Earth *investigation*	Group	Formative	• Use understanding of erosion to predict, observe, and explain the effects of water and wind on various earth materials.

Continued

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	Creative writing *rubric*	Individual	Formative	• Discriminate between fiction and nonfiction literature and identify several differences between fiction and nonfiction literature. • Identify the basic structure of a fictional story (beginning, middle, and end). • Plan and write a fictional story that includes a beginning, middle, and end.
1	Environment Changes *end of lesson assessment*	Individual	Summative	• Understand that the environment changes over time. • Understand that there are different reasons for environmental changes over time (natural and human created).
2	STEM Research Notebook *entries*	Individual	Formative	• Describe the life cycle changes of a butterfly. • Describe what kind of food butterflies need. • Describe how shadows can be used to tell time and how the Earth's movements cause changes in shadows.
2	Participation in class weather observations and analysis *Observation, STEM Research Notebook, and Participation Rubric*	Individual	Formative	• Chart, graph, identify, describe, and analyze patterns of local weather to make connections among daily weather, the seasons, and plant life cycles.
2	Participation in class recycling *Observation, STEM Research Notebook, and Participation Rubric*	Individual	Formative	• Sort recyclables each day. Measure (e.g., number of items, volume of items, or weight), chart, and graph daily recycling and compare daily tallies.

Continued

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
2	Team Research for Outdoor STEM Classroom *performance task*	Group	Formative	• Use the engineering design process (EDP) to plan an outdoor STEM classroom. • Draw a map of the outdoor STEM classroom design. • Identify supply needs for the outdoor STEM classroom. • Identify funding needs for the outdoor STEM classroom. • Use technology to facilitate deeper conceptual understanding. • Learn about how to design a watering system for an outdoor STEM classroom.
2	Creative writing *rubric*	Individual	Formative	• Identify dialogue in a story. • Write a fictional story using dialogue, quotation marks, and dialogue tags.
2	Butterfly Life Cycle *end of lesson assessment*	Individual	Summative	• Describe the life cycle changes of a butterfly. • Identify technological advances and tools that scientists use to learn about changes over time.
3	Participation in class weather observations and analysis *Observation, STEM Research Notebook, and Participation Rubric*	Individual	Formative	• Chart, graph, identify, describe, and analyze patterns of local weather to make connections among daily weather, the seasons, and plant life cycles.
3	Participation in class recycling *Observation, STEM Research Notebook, and Participation Rubric*	Individual	Formative	• Sort recyclables each day. Measure (e.g., number of items, volume of items, or weight), chart, and graph daily recycling and compare daily tallies.

Continued

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
3	Construction of Outdoor STEM Classroom *performance task*	Group	Formative	• Build outdoor STEM classroom areas. • Use the EDP to construct an outdoor STEM classroom. • Create a plan for maintenance of the outdoor STEM classroom.
3	Creative writing *rubric*	Individual	Formative	• Identify several ways that including illustrations enhances readers' experiences in reading fictional literature. • Create a work of fiction related to gardening that incorporates illustrations.
3	Observation Journal *performance task*	Group/Individual	Formative	• Create a data collection plan to observe environmental changes over time. • Use technology tools to gather data.
3	Seeds and Sun *end of lesson assessment*	Individual	Summative	• Describe how seeds are dispersed. • Explain how the Sun helps tell time.

MODULE TIMELINE

Tables 3.6–3.10 (pp. 37–41) provide lesson timelines for each week of the module. These timelines are provided for general guidance only and are based on class times of approximately 30 minutes.

Table 3.6. STEM Road Map Module Schedule for Week One

Day 1	Day 2	Day 3	Day 4	Day 5
Lesson 1 *Let's Explore Environmental Changes Over Time!* • Launch the module by introducing the module challenge with a discussion about observable changes in the environment over time. • Show time lapse video of changes on Earth. • Introduce weather chart.	*Lesson 1* *Let's Explore Environmental Changes Over Time!* • Interactive read-aloud of *Weather Forecasting* by Gail Gibbons. • Students write letters to principal asking for permission to create the outdoor STEM classroom. • Introduce classroom recycling program.	*Lesson 1* *Let's Explore Environmental Changes Over Time!* • Interactive read-aloud of *Dirt* by Steve "The Dirtmeister" Tomecek. • Begin class vocabulary chart. • Begin Eroding Earth investigation.	*Lesson 1* *Let's Explore Environmental Changes Over Time!* • Conduct Eroding Earth investigation. • Introduce creative writing by discussing differences between fiction and nonfiction literature. • Conduct an interactive read-aloud of *Velma Gratch and the Way Cool Butterfly* by Alan Madison and Kevin Hawkes.	*Lesson 1* *Let's Explore Environmental Changes Over Time!* • Conclude Eroding Earth investigation. • Show video about preventing soil erosion. • Introduce the basic parts of a fictional story and the Build Your Own Story graphic organizer.

Table 3.7. STEM Road Map Module Schedule for Week Two

Day 6	Day 7	Day 8	Day 9	Day 10
Lesson 1 *Let's Explore Environmental Changes Over Time!* • Discuss the timeframe of environmental changes such as erosion and plant growth and introduce scientific measurement. • Show a time lapse video of plant growth. • Students respond to a creative writing prompt related to an element of the outdoor STEM classroom. • Answer the Lesson Assessment questions.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Class discussion about butterflies and butterfly habitats. • Interactive read-aloud of *The Life Cycle of a Butterfly* by Bobbie Kalman.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Introduce sundials. • Interactive read-aloud of *Sun Up, Sun Down: The Story of Day and Night* by Jacqui Bailey.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Shadow Time activity.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Introduce the engineering design process (EDP). • Interactive read-aloud of *Rosie Revere, Engineer* by Andrea Beaty. • Begin the Using the EDP to Create a Birdbath activity. • Interactive read-aloud of *About Birds: A Guide for Children* by Cathryn Sill.

Table 3.8. STEM Road Map Module Schedule for Week Three

Day 11	Day 12	Day 13	Day 14	Day 15
Lesson 2 *Planning Our Outdoor STEM Classroom* • Continue the Using the EDP to Create a Birdbath activity. • Introduce dialogue as an element of fictional literature.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Begin planning for the module challenge with The EDP in Action: Designing the Outdoor STEM Classroom activity. • Introduce dialogue tags.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Continue planning for outdoor STEM classroom. • Student teams present their research on butterfly gardens and sundials. • Interactive read-aloud of *The Lion and the Bird* by Marianne Dubuc as an example of dialogue in a work of fiction.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Class measures the outdoor STEM classroom space and students create rough sketches of the space. • Introduce concept of budgeting and have students identify funding needs for outdoor STEM classroom. • Interactive read-aloud of *Math at the Bank: Place Value and Properties of Operations* by Ian F. Mahaney. • Students respond to a creative writing prompt, incorporating dialogue.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Students create maps of their visions for the outdoor STEM classroom and choose a final plan. • Students respond to a creative writing prompt, incorporating dialogue in their writing.

Table 3.9. STEM Road Map Module Schedule for Week Four

Day 16	Day 17	Day 18	Day 19	Day 20
Lesson 2 *Planning Our Outdoor STEM Classroom* • Students create a supply list. • Students create a budget for the outdoor STEM classroom. • Optional: Students develop a fundraising plan for the outdoor STEM classroom.	*Lesson 2* *Planning Our Outdoor STEM Classroom* • Students brainstorm ideas about how to track changes over time in the outdoor STEM classroom. • Answer Lesson Assessment questions. • Discuss careers.	*Lesson 3* *Outdoor STEM Classroom Design Challenge* • Interactive read-aloud of *The Curious Garden* by Peter Brown. • Introduce seed dispersion with class discussion on how seeds are dispersed in nature. • Introduce illustrations as a feature of fictional texts.	*Lesson 3* *Outdoor STEM Classroom Design Challenge* • Interactive read aloud of *Flip, Float, Fly: Seeds on the Move* by JoAnn Early Macken. • Spreading Seeds With the EDP activity. • A second interactive read-aloud of *The Lion and the Bird* by Marianne Dubuc, focusing on use of illustrations.	*Lesson 3* *Outdoor STEM Classroom Design Challenge* • Begin to build the outdoor STEM classroom (construct and plant butterfly garden and birdbath). • Class discussion about night and the night sky. • Interactive read-aloud of *Looking Through a Telescope* by Linda Bullock.

Table 3.10. STEM Road Map Module Schedule for Week Five

Day 21	Day 22	Day 23	Day 24	Day 25
Lesson 3 *Outdoor STEM Classroom Design Challenge* • Continue building outdoor STEM classroom (construct and plant butterfly garden and birdbath). • Students respond to creative writing prompt, using illustrations in their writing.	*Lesson 3* *Outdoor STEM Classroom Design Challenge* • Continue building outdoor STEM classroom (construct and plant butterfly garden and birdbath, begin constructing and installing sundial).	*Lesson 3* *Outdoor STEM Classroom Design Challenge* • Continue building outdoor STEM classroom (construct and install sundial). • Introduce scientific measurement.	*Lesson 3* *Outdoor STEM Classroom Design Challenge* • Create class observation journal.	*Lesson 3* *Outdoor STEM Classroom Design Challenge* • Create maintenance plan for outdoor STEM classroom. • Answer Lesson Assessment questions. **Ongoing** • Students observe and record data about and maintain outdoor STEM classroom. • Students create fictional texts and share with other students.

RESOURCES

The media specialist can help teachers locate resources for students to view and read about plants, pollination, the movement of the Earth around the Sun, telling time, sundials, and other topics. Special educators and reading specialists can help find supplemental sources for students needing extra support in reading and writing. Additional resources may be found online. Community resources for this module may include botanists and horticulturists.

REFERENCES

Keeley, P., and R. Harrington. 2010. *Uncovering student ideas in physical science, volume 1: 45 new force and motion assessment probes.* Arlington, VA: NSTA Press.

Koehler, C., M. A. Bloom, and A. R. Milner. 2015. The STEM Road Map for grades K–2. In *STEM Road Map: A framework for integrated STEM education,* ed. C. C. Johnson, E. E. Peters-Burton, and T. J. Moore, 41–67. New York: Routledge. *www.routledge.com/products/9781138804234.*

National Research Council (NRC). 1997. *Science teaching reconsidered: A handbook.* Washington, DC: National Academies Press.

WIDA. 2012. 2012 amplification of the English language development standards: Kindergarten–grade 12. *https://wida.wisc.edu/teach/standards/eld.*

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

Grade 2

STEM Road Map for Elementary School

Investigating Environmental Changes

What if you could challenge your second graders to design an outdoor STEM classroom with a butterfly garden, birdbath, and sundial? With this volume in the *STEM Road Map Curriculum Series*, you can!

Investigating Environmental Changes outlines a journey that will steer your students toward authentic problem solving while grounding them in integrated STEM disciplines. As are 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 make discoveries about a range of natural and human-created phenomena. Building the outdoor classroom will help students learn about changes in the natural environment that are associated with the Earth's movement around the Sun, including plant and animal life cycles. They will draw on life, Earth and environmental science, the engineering design process, mathematics, and English language arts to do the following:

- Develop a proposal for their outdoor classroom using persuasive language.
- Devise a data collection plan to analyze environmental changes over time.
- Explore local weather patterns and make connections among the patterns, seasons, and plant life cycles.
- Learn about recycling, including sorting and tracking recycled materials.
- Create works of fiction incorporating their outdoor STEM classroom.

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, *Investigating Environmental Changes* 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

NSTApress
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PB425X12
ISBN 978-1-68140-534-6

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