Rainwater Analysis

STEM Road Map for Elementary School

Grade 5

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

NSTA press
National Science Teachers Association

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Dr. Carla C. Johnson is the associate dean for research, engagement, and global partnerships and a professor of science education at Purdue University's College of Education in West Lafayette, Indiana. Dr. Johnson serves as the director of research and evaluation for the Department of Defense–funded Army Educational Outreach Program (AEOP), a global portfolio of STEM education programs, competitions, and apprenticeships. She has been a leader in STEM education for the past decade, serving as the director of STEM Centers, editor of the *School Science and Mathematics* journal, and lead researcher for the evaluation of Tennessee's Race to the Top–funded STEM portfolio. Dr. Johnson has published over 100 articles, books, book chapters, and curriculum books focused on STEM education. She is a former science and social studies teacher and was the recipient of the 2013 Outstanding Science Teacher Educator of the Year award from the Association for Science Teacher Education (ASTE), the 2012 Award for Excellence in Integrating Science and Mathematics from the School Science and Mathematics Association (SSMA), the 2014 award for best paper on Implications of Research for Educational Practice from ASTE, and the 2006 Outstanding Early Career Scholar Award from SSMA. Her research focuses on STEM education policy implementation, effective science teaching, and integrated STEM approaches.

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Dr. Erin Peters-Burton is the Donna R. and David E. Sterling endowed professor in science education at George Mason University in Fairfax, Virginia. She uses her experiences from 15 years as an engineer and secondary science, engineering, and mathematics teacher to develop research projects that directly inform classroom practice in science and engineering. Her research agenda is based on the idea that all students should build self-awareness of how they learn science and engineering. She works to help students see themselves as "science-minded" and help teachers create classrooms that support student skills to develop scientific knowledge. To accomplish this, she pursues research projects that investigate ways that students and teachers can use self-regulated learning theory in science and engineering, as well as how inclusive STEM schools can help students succeed. During her tenure as a secondary teacher, she had a National Board Certification in Early Adolescent Science and was an Albert Einstein Distinguished Educator Fellow for NASA. As a researcher, Dr. Peters-Burton has published over 100 articles, books, book chapters, and curriculum books focused on STEM education and educational psychology. She received the Outstanding Science Teacher Educator of the Year award from ASTE in 2016 and a Teacher of Distinction Award and a Scholarly Achievement Award from George Mason University in 2012, and in 2010 she was named University Science Educator of the Year by the Virginia Association of Science Teachers.

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RAINWATER ANALYSIS MODULE OVERVIEW

Paula Schoeff, Janet B. Walton, Carla C. Johnson, and Erin Peters-Burton

THEME: The Represented World

LEAD DISCIPLINE: Mathematics

MODULE SUMMARY

In this module, student teams use the engineering design process (EDP) to plan, construct, and test their own systems for collecting and reusing rainwater to irrigate a fictional community garden. Using their own school building and grounds as a design lab, students learn about measuring rainfall, volume calculations, and rainwater storage options. They also learn about Earth's four spheres and make observations about how the spheres interact. Students explore poetry, biographical texts, and persuasive writing related to module topics. Based on what they have learned, students formulate a message about watershed conservation for their local community and create materials for a public service advertising campaign to disseminate their message (adapted from Capobianco et al. 2015).

ESTABLISHED GOALS AND OBJECTIVES

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

- Create a rain gauge
- Analyze rainwater data to determine the best location for a water collection system
- Use mathematics to explore volume calculations in a variety of real-world scenarios
- Use an electronic spreadsheet to conduct repetitive volume calculations
- Use the EDP to create a design for a rainwater collection and delivery system
- Identify how water is distributed throughout Earth's four spheres

- Research and analyze irrigation and water collection systems used in agriculture
- Present a proposal for a rainwater collection system
- Recognize that the environment can be modified over time by human activities and that these modifications can have both positive and negative consequences

CHALLENGE OR PROBLEM FOR STUDENTS TO SOLVE: THE RAINWATER ROUNDUP CHALLENGE

As the culminating activity for the module, student teams are challenged to design rainwater-recycling systems to provide water for a fictional community garden. Students use information about the interconnectedness of Earth's spheres, mathematical modeling, rainfall analysis, and irrigation as they work toward the goal of designing the systems and creating presentations that describe the design process and the systems' features.

Driving Question: How can we use what we know about rainfall to design a system to provide water to a garden?

CONTENT STANDARDS ADDRESSED IN THIS STEM ROAD MAP MODULE

A full listing with descriptions of the standards this module addresses can be found in the appendix. 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.

Each lesson in this module includes student handouts that should be kept in the STEM Research Notebooks after completion, as well as prompts to which students should respond in their notebooks. Students will have the opportunity to create covers and tables of contents for their Research Notebooks in Lesson 1. You may also wish to have students include the STEM Research Notebook Guidelines student handout on page 26 in their notebooks.

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.

STUDENT HANDOUT

STEM RESEARCH NOTEBOOK GUIDELINES

STEM professionals record their ideas, inventions, experiments, questions, observations, and other work details in notebooks so that they can use these notebooks to help them think about their projects and the problems they are trying to solve. You will each keep a STEM Research Notebook during this module that is like the notebooks that STEM professionals use. In this notebook, you will include all your work and notes about ideas you have. The notebook will help you connect your daily work with the big problem or challenge you are working to solve.

It is important that you organize your notebook entries under the following headings:

1. **Chapter Topic or Title of Problem or Challenge:** You will start a new chapter in your STEM Research Notebook for each new module. This heading is the topic or title of the big problem or challenge that your team is working to solve in this module.
2. **Date and Topic of Lesson Activity for the Day:** Each day, you will begin your daily entry by writing the date and the day's lesson topic at the top of a new page. Write the page number both on the page and in the table of contents.
3. **Information Gathered From Research:** This is information you find from outside resources such as websites or books.
4. **Information Gained From Class or Discussions With Team Members:** This information includes any notes you take in class and notes about things your team discusses. You can include drawings of your ideas here, too.
5. **New Data Collected From Investigations:** This includes data gathered from experiments, investigations, and activities in class.
6. **Documents:** These are handouts and other resources you may receive in class that will help you solve your big problem or challenge. Paste or staple these documents in your STEM Research Notebook for safekeeping and easy access later.
7. **Personal Reflections:** Here, you record your own thoughts and ideas on what you are learning.
8. **Lesson Prompts:** These are questions or statements that your teacher assigns you within each lesson to help you solve your big problem or challenge. You will respond to the prompts in your notebook.
9. **Other Items:** This section includes any other items your teacher gives you or other ideas or questions you may have.

MODULE LAUNCH

Launch the module by telling students that they will devise a way to capture and reuse rainwater. Then, hold discussions on the role water plays in supporting life on Earth and the idea that freshwater resources are limited. Show students the slide presentation "Water and Life" at *http://tinyurl.com/WaterAndLife,* which explains the importance of water and its role in supporting life on Earth. Then, ask students to review the distribution of water sources on Earth and discuss the idea that water is a precious resource that must be protected. Next, have the class read together the Rainwater Roundup Challenge scenario to introduce the design challenge for the module. The scenario involves the characters Mamito Anna and Grandpa Henry, who are looking for a solution to the problem of providing water to a garden, as well as Jorge and Angie, students at the fictional Wilbur Wright Elementary School, who help solve the problem. Students learn that Wilbur Wright Elementary resembles their school and grounds in size and shape and are challenged to use their own campus as a design lab to formulate a solution to the problem presented.

PREREQUISITE SKILLS FOR THE MODULE

Students enter this module with a wide range of preexisting skills, information, and knowledge. Table 3.1 (p. 28) 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 Knowledge
Science • Water's natural tendency is to flow downhill, and energy is required to move water to a higher level. • Water and air are necessary for life.	*Science* • Identify Earth's water sources and conclude that water circulates through all four of Earth's spheres. • Create models to show that water carries chemicals and pollutants that may affect the environment far away. • Conclude that farmers and gardeners often use irrigation and water collection systems to help provide some of the water needs for fields and gardens.	*Science* • Provide demonstrations and physical models of water movement and irrigation methods. • Review the basic needs of living things. • Provide a variety of nonfiction literature sources about water and the needs of living things.
Inquiry Skills • Ask questions, make logical predictions, plan investigations, and represent data. • Use senses and tools to make observations. • Communicate understanding of data using age-appropriate vocabulary.	*Inquiry Skills* • Select and use appropriate tools and equipment to conduct investigations. • Maintain a notebook that includes observations, data, diagrams, and reflections. • Analyze and communicate findings from multiple investigations of similar phenomena to reach a conclusion.	*Inquiry Skills* • Model selection and use appropriate tools and simple equipment to conduct an investigation. • Provide samples of STEM Research Notebook pages. • Scaffold student efforts to organize data into appropriate tables, graphs, drawings, or diagrams by providing step-by-step instructions. • Identify specific investigations that could be used to answer a particular question, and explain reasons for this choice.

Continued

Table 3.1. (*continued*)

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Knowledge
Numbers and Representation • Convert numbers from fractions to decimals. • Understand place value of decimal numbers. • Multiply, add, and subtract decimal numbers to thousandths place. • Understand that measurements expressed as numbers have various units associated with them.	*Numbers and Representation* • Use mathematics operations when creating tables and graphs for storing and analyzing data. • Express measurements using appropriate units.	*Numbers and Representation* • Review properties of operations using examples of volume and distance. • Use textbook support, teacher instruction, models, graphic organizers, and online instruction to provide practice.
Measurement Skills • Measure volume and distance with appropriate tools and units. • Make precise measurements. • Convert units of measurement. • Understand the concept of scale, and create scaled drawings. • Understand how to use a protractor.	*Measurement Skills* • Make linear measurements and convert them to their decimal equivalents. • Measure volumes of water using cylinders and measuring cups. • Construct their own measurement tools to solve specific problems. • Convert units of measurement. • Create scaled drawings of the school grounds and school building. • Use a protractor to create a tool to measure angles in the schoolyard.	*Measurement Skills* • Provide opportunities to practice measuring with precision, using the correct units. • Provide a table that offers visual reinforcement of measurements and units. • Provide instruction in use of cylinders and measuring cups for finding volume. • Provide handouts to offer guidance in measuring and conversion. • Provide examples of scale using maps, and model the use of scale by working as a class to create a scaled drawing of the classroom. • Review protractor use with the class, providing opportunities for students to use protractors to measure both inside and outside angles in the classroom.

Continued

Table 3.1. (*continued*)

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Knowledge
Geometry • Identify quadrants on a coordinate grid. • Identify points on a coordinate grid. • Recognize three-dimensional (3-D) geometric shapes. • Understand that modeling scales are a ratio of the measurement on a drawing compared with the measurement of the original object. • Understand and measure angles and understand the principle of opposite angles.	*Geometry* • Plot points on a coordinate grid. • Identify and employ fundamental geometric shapes in real-world structures. • Make multiview drawings of 3-D objects. • Measure angles in the schoolyard, using the principle of opposite angles to measure exterior angles.	*Geometry* • Demonstrate the use of coordinate grids, and provide opportunities for students to practice plotting points and identifying quadrants. • Provide opportunities to measure 3-D cubes and rectangular solids. • Provide opportunities to find the volume of cylindrical shapes. • Demonstrate the principle of opposite angles, and provide opportunities to apply this concept to measure exterior angles in the classroom.
Reading Skills • Read grade-level science texts, and decode words using phonics and word analysis skills. • Use information gained from illustrations and text to understand science concepts. • Draw inferences from informational text.	*Reading Skills* • Research and report on the importance of water on Earth. • Use the internet and grade-appropriate texts to conduct research. • Read fiction and nonfiction texts that portray topics from the module in a variety of ways.	*Reading Skills* • Provide reading strategies to support comprehension of nonfiction texts, including using vocabulary notecards and games, graphic organizers, STEM Research Notebooks, and discussions. • Through class read-alouds, model interpreting illustrations and graphics in texts and drawing inferences from informational texts.
Writing Skills • Use science terms to write informative texts and explain thoughts and ideas about rainwater collection systems. • Use key terminology as words and pictures. • Provide evidence to support ideas and opinions about topics.	*Writing Skills* • Write informative and explanatory narratives to convey ideas and information clearly. • Write narratives to describe experiences using effective techniques, descriptive details, and clear event sequences.	*Writing Skills* • Provide templates or graphic organizers for writing. • Model organizational techniques for writing. • Provide rubrics for students to assess their own writing.

Continued

Table 3.1. (*continued*)

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Knowledge
Communication Skills • Participate in collaborative conversations using appropriate language and skills. • Effectively support scientific knowledge with appropriate language and relevant, descriptive details.	*Communication Skills* • Engage in a number of collaborative discussions that support learning. • Create a presentation to share classroom experiences and research.	*Communication Skills* • Scaffold student understanding of communication skills by providing examples of appropriate language and presentation. • Provide handouts and rubrics to support organization of facts and use of relevant descriptive details.

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 in order 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 Rainwater Analysis module and how they align to the self-regulated learning (SRL) process before, during, and after learning.

Table 3.2. SRL Process Components

Learning Process Components	Example From Rainwater Analysis Module	Lesson Number and Learning Component
BEFORE LEARNING		
Motivates students	Students are told that they will devise a way to capture and reuse rainwater. Then, they discuss the role water plays in supporting life on Earth and the idea that freshwater resources are limited.	Lesson 1, Introductory Activity/Engagement
Evokes prior learning	Students use prior knowledge in discussing water's role in supporting life on Earth.	Lesson 1, Introductory Activity/Engagement
DURING LEARNING		
Focuses on important features	Students complete a home survey of features that handle rainwater, then share their findings with classmates.	Lesson 2, Activity/ Exploration
Helps students monitor their progress	Student teams compare their rain gauge data with the other teams' data and with rainfall data from their area. Students discuss reasons for variations in data.	Lesson 2, Elaboration/ Application of Knowledge
AFTER LEARNING		
Evaluates learning	Students get feedback on their final challenge product from detailed rubrics.	Lesson 4, Elaboration/ Application of Knowledge
Takes account of what worked and what did not work	Students reflect on the feedback they receive when they present to the principal and other stakeholders.	Lesson 4, 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 rainwater and horticulture using scientific inquiry, fiction and nonfiction literature, journaling, and collaborative design). Differentiation strategies for students needing support in prerequisite knowledge can be found in Table 3.1 (p. 28). 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.

Flexible Grouping. Students work collaboratively in a variety of activities throughout this module. Grouping strategies you may choose to 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, reading a variety of texts, writing about module topics using various genres of literature, 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, electronic slide 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. Because student work in science and mathematics is largely collaborative throughout the module, this strategy may be most appropriate for ELA or social studies activities. You may wish to compile a classroom database of research resources and supplementary readings for a variety of reading levels and on a variety of topics 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 set of topical resources at a variety of reading levels.

Mentoring. As group design teamwork becomes increasingly complex throughout the module, you may wish to have a resource teacher, older student, or parent 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. The focus on rainwater affords an opportunity for ELL students to share culturally diverse experiences with climate conditions, horticulture, and agriculture.

Teachers differentiating instruction for ELL students should carefully consider the needs of these students as they introduce and use academic language in various language domains (listening, speaking, reading, and writing) throughout this module. To adequately differentiate instruction for ELL students, teachers should have an understanding of the proficiency level of each student. The following five preK–5 WIDA learning standards are relevant to this module:

- Standard 1: Social and Instructional Language. Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace; add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.

- Standard 2: The language of Language Arts. Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
- Standard 3: The language of Mathematics. Use a pair of perpendicular number lines, called axes, to define a coordinate system. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane and interpret coordinate values of points in the context of the situation.
- Standard 4: The language of Science. Focus on forces in nature, scientific process, Earth and sky, living and nonliving things, organisms and environment, and weather.
- Standard 5: The language of Social Studies. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

SAFETY CONSIDERATIONS FOR THE ACTIVITIES IN THIS MODULE

This module's science component focuses on water and its interaction with living things. Ensure that any water spilled on the floor is cleaned up promptly to avoid slipping. See the safety notes in each lesson pertaining to the specific activities in that lesson. For more general safety guidelines, see the Safety in STEM section in Chapter 2 (p. 18).

DESIRED OUTCOMES AND MONITORING SUCCESS

The desired outcomes for this module are outlined in Table 3.3 (p. 36), 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 recognize water's essential role to life on Earth. • Students can apply an understanding of the hydrosphere and water collection to create a model of a rainwater collection system. • Students share their learning through writing and presentations.	• Students maintain STEM Research Notebooks that contain graphic organizers with data from investigations, sketches, research notes, evidence of collaboration, and ELA-related work. • Students use their school playground as a design lab to plan a rainwater-recycling system to be used in a fictional garden presented in a scenario. • Students can defend their design decisions. • Students are assessed using rubrics that focus on learning and application of skills related to the academic content.	• STEM Research Notebooks are assessed using a rubric. • Student collaboration is evaluated using self-assessment reflections, peer feedback, and a collaboration 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 (p. 38) 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	• Playing Card Challenge • Rain Gauge Design Challenge • Watershed conservation research	• Watershed Model • Watershed Place Mat • Volume Conversion Table • Original poem • STEM Research Notebook entries
2	• Surveyor Tools • Schoolyard Surveyors • Schoolyard Map • Build Your Own Biodome	• Rainwater at Home Survey • Earth's Spheres Poster • Biography of a Classmate • STEM Research Notebook entries
3	• What's the Volume? • How Big Is Big Enough? • Writing the OREO Way as a group • Irrigation research • Way to Flow: Capillary Action • The Great Escape: Capillary Action	• Writing the OREO Way individually • Understanding Weather Data • STEM Research Notebook entries
4	• Cylinder Volume spreadsheet • Collection Tank Design Challenge • Garden Water Investigation • Water Distribution Design Challenge • Rainwater Roundup Challenge • Rainwater Roundup Slideshow • Public Service Advertising Campaign materials	• STEM Research Notebook entries

Table 3.5. Assessment Map for Rainwater Analysis Module

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	Playing Card Challenge *handout*	Group	Formative	• Calculate the volume of a small item that cannot be physically measured with the tools available.
1	Rain Gauge Design Challenge *rubric*	Group	Formative	• Design a water gauge and place several throughout the schoolyard. • Track the amount of water that falls in a variety of locations throughout the schoolyard.
1	Watershed Model *activity*	Individual	Formative	• Recognize the value of water on Earth.
1	Watershed research and Watershed Place Mat *rubric*	Individual	Formative	• Research the importance of a community's watershed and propose ways that farmers and the community might protect it.
1	Volume Conversion Table	Individual	Formative	• Calculate the volume of a small item that cannot be physically measured with the tools available.
1	Poetry Writing *rubric*	Individual	Formative	• Understand that poetry can be used to express feelings and communicate ideas about phenomena in the natural world. • Use this understanding to create an original poem related to module topics.
2	Rainwater at Home Survey *handout*	Individual	Formative	• Identify features of buildings that keep rainwater from entering the buildings.
2	Surveyor Tools *handout*	Group	Formative	• Understand that specialized instruments are used to measure large spaces. • Design measuring instruments to measure the school building and schoolyard.

Continued

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
2	Schoolyard Surveyors *handout*	Group	Formative	• Use measuring instruments to measure the school building and schoolyard. • Recognize features of buildings that serve to keep rainwater outside the buildings. • Use observations of rainwater handling features to predict where rainwater goes when it is channeled away from the building. • Measure the footprint (amount of space covered by an object) of large structures such as the school building and grounds.
2	Schoolyard Map *rubric*	Group	Formative	• Build a scale map of the schoolyard.
2	Build Your Own Biodome *handout* or EDP Applied to the Biodome *handout*	Group	Formative	• Create a biodome model, a small terrarium that mimics the conditions of natural ecosystems.
2	Map Detective *activity*	Group	Formative	• Use maps to make inferences about how Earth's major systems interact.
2	Earth's Spheres *poster*	Individual	Formative	• Identify the four Earth spheres (biosphere, geosphere, hydrosphere, and atmosphere). • Provide examples of the ways that each of Earth's four systems interact with each other. • Create a model showing how Earth's major spheres interact.
2	Biography of a Classmate *rubric*	Individual	Formative	• Identify the characteristics of biographical writing. • Identify the difference between primary and secondary sources. • Write a biographical text.
2	Collaboration *rubric*	Individual	Formative	• Use collaboration skills to accomplish work as members of a team.

Continued

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
3	What's the Volume? *handout*	Group	Formative	• Calculate the volume of rainwater that falls on the playground on one morning.
3	How Big Is Big Enough? *handout*	Group	Formative	• Design a tank to hold a given amount of water.
3	Way to Flow: Capillary Action *handout*	Group	Formative	• Describe capillary action and identify it as the mechanism by which water is moved from soil to various parts of plants.
3	Writing the OREO Way *handout*	Individual/ Group	Formative	• Propose some ways that humans can protect the hydrosphere. • Construct a message about watershed protection using persuasive writing techniques.
3	Irrigation *research*	Group	Formative	• Identify and describe various irrigation techniques. • Evaluate agricultural practices and propose alternative strategies for those that may have harmful impacts on the environment.
3	Understanding Weather Data *spreadsheet or table and graph*	Individual	Formative	• Collect and graph historical rainfall data. • Create and analyze a graph to compare and contrast schoolyard rainfall measurements with statistics for rainfall in the surrounding area in a typical year.
3	The Great Escape: Capillary Action *handout*	Group	Formative	• Provide examples of ways that human activities (the biosphere) can negatively impact Earth's other spheres.
4	Cylinder Volume *spreadsheet tables and graphs*	Group	Formative	• Use a spreadsheet to create a way to conduct repetitive calculations. • Calculate the volume of rectangular solids and cylinders of given dimensions.

Continued

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
4	Collection Tank Design Challenge *rubric*	Group	Summative	• Design a system to store a specified amount of water.
4	Garden Water Investigation *handout*	Group	Summative	• Calculate the volume of rectangular solids and cylinders of given dimensions. • Use understanding of irrigation techniques to propose an irrigation system for a garden.
4	Water Distribution Design Challenge *rubric*	Group	Summative	• Create a model of an irrigation system.
4	Rainwater Roundup Challenge *rubric*	Group	Summative	• Synthesize learning from the module to create a model of a rainwater capture system that includes rainwater storage and a way to deliver stored rainwater to a garden.
4	Rainwater Roundup Slideshow *rubric*	Group	Summative	• Create a slideshow presentation for the rainwater capture system and the process used to create the system.
4	Public Service Advertising Campaign *rubric*	Group	Summative	• Synthesize learning from the module to create persuasive text to convey a message about watershed protection to the public in a media format.

MODULE TIMELINE

Tables 3.6–3.10 (pp. 42–46) provide lesson timelines for each week of the module. The timelines are provided for general guidance only and are based on class times of approximately 45 minutes.

Table 3.6. STEM Road Map Module Schedule for Week One

Day 1	Day 2	Day 3	Day 4	Day 5
Lesson 1 *Water, Water Everywhere!* • Launch the module with discussions on the role water plays in supporting life on Earth and the idea that freshwater resources are limited. • View a slideshow that provides an overview of the water cycle and potable water and its importance for life on Earth. • Introduce the Rainwater Roundup Challenge, using a scenario about watering needs for a garden at the Sunny Acres retirement home.	*Lesson 1* *Water, Water Everywhere!* • Use a demonstration and an electronic spreadsheet to illustrate the distribution of potable water on Earth. • Introduce concepts associated with measuring rainfall and measuring volume. • Conduct a demonstration about volume. • Introduce Volume Conversion Table activity. • Introduce poetry related to rain. • Introduce the concept of the watershed.	*Lesson 1* *Water, Water Everywhere!* • Students construct conversion tables. • Students begin the Playing Card Challenge, in which they calculate the volume of a single playing card. • Introduce the Rain Gauge Design Challenge. • Introduce several types of poetry. • Students create a watershed model.	*Lesson 1* *Water, Water Everywhere!* • Students present and discuss their conversion tables. • Students complete the Playing Card Challenge. • Students build rain gauges in the Rain Gauge Design Challenge and place them in locations around the school grounds. • Continue to discuss and provide examples (related to the module topic) of types of poetry. • Hold a class discussion about the importance of the watershed and potential effects of human activities on the watershed.	*Lesson 1* *Water, Water Everywhere!* • Students begin to devise a data collection plan for their rain gauges. • Students begin to create their own poetry related to the module topic. • Students conduct research about the watershed and watershed protection.

Table 3.7. STEM Road Map Module Schedule for Week Two

Day 6	Day 7	Day 8	Day 9	Day 10
Lesson 1 *Water, Water Everywhere!* • Students practice calculating volume for rectangular solids using an example of calculating the volume of paint needed to paint their classroom. • The class finalizes the collection plan for rain data. • Students continue to write their own poetry based on the module topic. • Students create place mats that synthesize their research about the watershed and watershed protection.	*Lesson 1* *Water, Water Everywhere!* • Introduce the concept of engineering design by a read-aloud of a book about the design of the Mars rovers. • Students share their poetry and provide feedback to others about their poems. • Students share their place mats with the class.	*Lesson 2* *Earth's Spheres* • Introduce and discuss the idea that Earth is a system made up of subsystems known as spheres. • Begin the Earth's Spheres Poster activity. • Read aloud *Rachel Carson and Her Book That Changed the World* by Laurie Lawlor as an example of biographical writing and how writing can inform the public about environmental issues. • Discuss science and engineering careers and their relationship to Earth's spheres.	*Lesson 2* *Earth's Spheres* • Begin the Rainwater at Home activity. • Introduce concepts associated with measuring large areas. • Begin the Schoolyard Surveyors activity. • Continue the investigation of Earth's spheres with a discussion about how the spheres interact with plant growth. • Introduce the Build Your Own Biodome activity. • Students investigate biographies. • Introduce the idea that geography influences how Earth's spheres appear and how they interact. • Begin the Map Detective activity.	*Lesson 2* *Earth's Spheres* • Complete the Rainwater at Home activity. • Complete the Schoolyard Surveyors activity. • Students create biodomes in the Build Your Own Biodome activity. • Introduce the idea of information sources for biographies. • Students formulate interview questions to ask classmates. • Continue the Map Detective activity.

Table 3.8. STEM Road Map Module Schedule for Week Three

Day 11	Day 12	Day 13	Day 14	Day 15
Lesson 2 *Earth's Spheres* • Begin the Schoolyard Map activity. • Complete biodomes and hold a class discussion about the features of the biodome. • Students interview classmates and share findings. • Complete the Map Detective activity.	*Lesson 2* *Earth's Spheres* • Complete the Schoolyard Map activity. • Students calculate the volume of rain that falls on the school building during a rain event. • Students begin to write biographies about their classmates based on their interview source information.	*Lesson 2* *Earth's Spheres* • Students brainstorm ways to collect rainwater from the school building. • Students share and discuss their solutions for calculating rain volume. • Students continue to write their biographies.	*Lesson 2* *Earth's Spheres* • Students share their rainwater collection ideas and consider the associated challenges. • Students practice rainwater volume calculations using various scenarios. • Students share their biographies and provide and receive feedback.	*Lesson 3* *How Much Rain Can We Catch?* • Introduce the idea of hydrosphere protection in the community using a slideshow and class discussion. • Discuss water shortages and their implications for communities and for agriculture. • Introduce public service advertising (PSA) and persuasive text.

Table 3.9. STEM Road Map Module Schedule for Week Four

Day 16	Day 17	Day 18	Day 19	Day 20
Lesson 3 *How Much Rain Can We Catch?* • Optional: Have the school custodian or building manager visit the class to review students' schoolyard maps and provide feedback and additional information. • Begin What's the Volume? activity to calculate rainfall on the school playground. • Introduce the concept of capillary action. • Do the Way to Flow: Capillary Action activity. • Students explore persuasive writing and begin to formulate a message about watershed protection for their community.	*Lesson 3* *How Much Rain Can We Catch?* • Complete the What's the Volume? activity. • Calculate rainwater tank collection volumes in the How Big Is Big Enough? activity. • Continue to create and refine a message about watershed protection for the community. • Discuss the governmental decision-making processes for water usage. • Introduce irrigation research.	*Lesson 3* *How Much Rain Can We Catch?* • Introduce the Understanding Weather Data activity. • Do the Great Escape: Capillary Action activity. • Students consider ways to disseminate their information about watershed protection in a PSA campaign. • Continue irrigation research.	*Lesson 3* *How Much Rain Can We Catch?* • Complete Understanding Weather Data activity. • Students compare their rain gauge data with overall rainfall statistics for their area. • Students agree on a class message about community watershed protection and decide on the media each team will be responsible for. • Optional: Students take a farm or greenhouse field trip or listen to an in-class speaker.	*Lesson 4* *The Rainwater Roundup Challenge* • Review how the EDP will be applied to the module challenge. • Do the Acme Tank Works activity. • Student teams work on creating their media components for the class PSA campaign about watershed protection in their community.

Table 3.10. STEM Road Map Module Schedule for Week Five

Day 21	Day 22	Day 23	Day 24	Day 25
Lesson 4 *The Rainwater Roundup Challenge* • Complete the Collection Tank Design Challenge. • Student teams work on creating their media components for the class PSA campaign.	*Lesson 4* *The Rainwater Roundup Challenge* • Complete the Garden Water Investigation. • Student teams continue to work on their media components for the class PSA campaign.	*Lesson 4* *The Rainwater Roundup Challenge* • Complete the Water Distribution Design Challenge. • Students begin creating their slideshow presentations. • Student teams continue to work on their media components for the class PSA campaign.	*Lesson 4* *The Rainwater Roundup Challenge* • Complete the Rainwater Roundup Challenge. • Students complete their slideshow presentations. • Student teams complete their media components for the class PSA campaign.	*Lesson 4* *The Rainwater Roundup Challenge* • Students give presentations of their Rainwater Roundup slideshows and media components of the class PSA campaign.

RESOURCES

The media specialist can help teachers locate resources for students to view and read about recreational equipment, parks, and related physics content. 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 civil engineers, environmental engineers, and rainwater handling product manufacturing representatives.

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

Grade 5

STEM Road Map for Elementary School

Rainwater Analysis

What if you could challenge your fifth graders to design rainwater recycling systems to provide water for a fictional community garden? With this volume in the *STEM Road Map Curriculum Series*, you can!

Rainwater Analysis 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 this series, this book is designed to meet the growing need to infuse real-world learning into K–12 classrooms.

The book is an interdisciplinary module that uses project- and problem-based learning. Using their own school building and grounds as a design lab, student teams will be challenged to develop rainwater collection and delivery systems. They will draw on Earth and environmental science, mathematics, the engineering design process, and English language arts to do the following:

- Create a rain gauge, measure rainfall, and analyze rainwater data to determine the best location for a water collection system.
- Explore volume calculations in real-world scenarios and use a spreadsheet to conduct repetitive volume calculations.
- Identify how water is distributed throughout the Earth's four spheres and research irrigation and water collection systems used in agriculture.
- Study poetry, biographical texts, and persuasive writing related to module topics.
- Present a proposal for a rainwater collection and storage system, including a message about watershed conservation for their local community and a public service advertising campaign.

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, *Rainwater Analysis* 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 5

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