Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 5 Science
Unit 3 Sample Lesson "Can You Catch the Water?"
Earth Systems and the Solution of Water Problems
January 2023

The SIPS Grade 5 Science Unit 3 Sample Lesson "Can You Catch the Water?", Earth Systems and the Solution of Water Problems was developed with funding from the U.S. Department of Education under the Competitive Grants for State Assessments Program, CFDA 84.368A. The contents of this paper do not represent the policy of the U.S. Department of Education, and no assumption of endorsement by the Federal government should be made.

Science Grade 5

Unit 3: Earth Systems and the Solution of Water Problems

Sample Lesson: Can You Catch the Water?

Suggested Time to Complete: 50 Minutes

Purpose & Use Statement: *This sample lesson was developed for state and local administrators and teacher leaders (e.g., curriculum directors, instructional facilitators, professional learning specialists) to (1) illustrate an example of an instructional lesson developed using a principled design approach, and (2) support accompanying process documentation about how to use the SIPS unit as an instructional framework to intentionally design high-quality lessons in an aligned curriculum, instruction, and assessment system. This sample lesson should be evaluated and refined, as necessary, to align appropriately with a standards-based curriculum, instruction, and assessment system prior to its use. Additionally, teachers should refine this lesson to meet the local, cultural, and individual needs of the students.*

Desired Results

Overview of the Learning Goals

In this lesson, "Can You Catch the Water?", students engage with Big Idea 2 (The Roles of Water in Earth's Surface Processes) to model and better understand how and why water collects into catchments and watersheds. Students create functions-like models from household materials to create a topographic surface. Students use this model to experiment with rainfall and water flow to observe how water moves across surfaces and predict how it would move through runoff and groundwater infiltration in the natural environment. Students use information and data from this modeling to refine and improve their own explanatory models of where a glass of water comes from, and what happens to it.

Connections to Prior Learning (K-5)

DCI: ESS2.C, ESS2.A

- Wind and water can change the shape of the land.
- Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.
- Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.
- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over the years.
- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

SEP: 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, or storyboard) that represent concrete events or design solutions.
- Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

SEP: Analyzing and Interpreting Data

- Students begin to analyze data in K–2 that builds on prior experiences and progress to collecting, recording, and sharing observations.
- In grades 3-5, students represent data in tables and/or various graphical displays to reveal patterns that indicate relationships. They analyze data to refine a problem statement or the design of a proposed object, tool, or process.

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CCC: Systems and System Models

- In grades K–2, students understand that objects and organisms can be described in terms of their parts and that systems in the natural and designed world have parts that work together.
- In grades 3–5, students understand that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. They can also describe a system in terms of its components and their interactions.

CCC: Cause & Effect

- **Prior learning from K-2:** Students are expected to understand that events can be described in terms of cause(s) and effect(s) and have some experience identifying causes and/or effects.
- In grades K-2, students learn that events have causes that generate observable patterns. They design simple tests to gather evidence to support or refute their ideas about causes. [Appendix G]
- **Prior learning from this grade band (e.g., Grades 3 & 4 and/or prior SIPS G5 units):** During grades 3-5, students are expected to become adept at identifying/testing causes and effects, and to become aware that events can be correlated but not causally related.

CCC: Patterns

- **Prior learning from K-2:** Students are expected to have experience observing patterns in nature, which guide the organization and classification of and prompt questions about relationships and causes underlying them.
- In grades K-2, students learn that patterns in the natural and human-designed world can be observed, used to describe phenomena, and used as evidence. [Appendix G]
- **Prior learning from this grade band (e.g., Grades 3 & 4 and/or prior SIPS G5 units):** During grades 3-5, students are expected to see how patterns can be used to make predictions, support an explanation, and make sense of simple rates of change for natural phenomenon and designed products.
- Multiple grade 3 and grade 4 PEs use this CCC, so students will likely have some experience with the CCC's grades 3-5 elements prior to starting grade 5.

Key Vocabulary

Students build conceptual meaning with and use key tier II and tier III vocabulary terms to make sense of phenomena and phenomena-based design problems. This is not an exhaustive list of terms and should be reviewed and modified by educators, as appropriate.

- System
- Earth surface
- Human impact criteria
- Hydrosphere
- Geosphere
- Biosphere
- Atmosphere
- Landforms
- Interaction

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Targeted Stage 1 Learning Goals

Acquisition Goals (AG)

A5. Define the problem provided to them in ways that specify criteria for success and the nature of the resources and materials that will be used in solving the problem.*
A6. Use information on available resources, materials, and prior design ideas to support the elements of their design.*
A7. Present the definition of the problem in the form of a system model that documents how a possible solution will address the given problem using available resources and addressing possible constraints.
A8. Specify a design that provides a solution to a given problem, indicating the way resources and materials will support meeting the design criteria and addressing constraints.
A14. Obtain and evaluate information from a variety of sources as the basis for claims about the positive or negative impact of human activities on Earth's system.*
A15. Design and carry out an investigation to characterize the impact of human activities on a particular design solution.*
A16. Modify a design solution using information on the impact of human activities on the outcome of the solution, including specifying the way that the human activities can be reversed or addressed.*
A17. Design investigations where different conditions are considered relative to the outcomes that are important for a design solution.*

Common Core State Standards (CCSS):

[None}	

Engineering, Technology, and the Application of Science

ETS1.A	ETS1.B	ETS1.C

Enduring Understandings (EU)/ Essential Questions (EQ):

EU3/EQ3	EU4/EQ4	EU5/EQ5

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
☐ Analyze & Interpret Data ☐ Ask Questions ☒ Construct Explanations (3-5-ETS1-2) ☐ Define Problems ☐ Design Solutions ☒ Develop & Use Models (5-ESS2-1) ☐ Engage in Argument from Evidence ☐ Mathematics & Computational Thinking ☒ Obtain, Evaluate, & Communicate Information (5-ESS3-1) ☐ Plan & Carry Out Investigations	☒ ESS2.A: Earth Materials and Systems ☒ ESS2.C: The Roles of Water in Earth's Surface Processes	☒ Cause & Effect ☐ Energy & Matter ☐ Patterns ☐ Scale, Proportion, & Quantity ☐ Stability & Change ☐ Structure & Function ☒ Systems & System Models (5-ESS2-1) (5-ESS3-1)

Formative Assessment Opportunities

Monitoring	Success Criteria	Possible Instructional Adjustments
• Teacher questioning • Open-ended and non-evaluative statements to encourage students to share	Students can: • Recognize the features of local catchments and landforms and represent	• Students may need support in finding or recognizing landforms in the area and may not be aware of all local landforms. The teacher may

observations and make predictions	them in drawings and pictures • Make observations and recognize patterns of common features in catchments • Communicate their thinking about the observations and patterns they see	want to have additional images/resources in reserve • Use questioning and encourage students to add different observations ("what can we add?") if students struggle to share different observations
• Teacher questioning while students work in small groups • Observations and listening to students as they work in their small groups • Student model diagrams, labels, and text	Students can: • Create a model of a local catchment • Model and observe the movement of water through the catchment and document that movement in diagrams and text • Predict and verify the impact of changes to the functions-like model caused by human interactions with the environment	• Provide images/examples of human interactions in local catchments • Use questioning to provide guidance for students needing support around the usage of materials
• Teacher questioning while students work on their explanation • Observations of student explanations and the modifications students make	• Incorporate additional information from the functions-like model into their scientific explanation	• Use Socratic questioning and minimal support to encourage students to consider new learning and how this new information can support or refute elements of their model.

Instructional Plan

Lesson Overview

In this lesson, students build functions-like models to simulate the real-world topography of a local landform and catchment basin. Students use household materials to explore the movement of water through the catchment and then introduce changes to explore the impact of these changes. This lesson is an adaptation of the lesson found at https://www.teachengineering.org/activities/view/cub_earth_lesson2_activity3. Much of the support and guidance from the teacher has been removed to support more inquiry, exploration, and discovery by the students.

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- **Engage:** Students look at images of local landforms and catchment basins from different perspectives and share initial observations and patterns with the class.
- **Explore:** Using images, maps, and other resources, students build models of catchment basins and then use their models to simulate the movement of water through the basin. The students document their models through drawings and writing with clear labels. Students model changes to the catchment and then document how those changes impacted the catchment basin.
- **Explain:** Students add to their explanatory model on the glass of water information about catchments and the storage of groundwater.

Materials & Set-Up

For each group:

- Sticky notes
- A variety of objects to build landforms, such as small cups, jars, bowls, plates, rocks, blocks, crunched paper towels, etc.
- Sheet of light-weight plastic, ~1 x 1 meter (a slit-open trash bag works well)
- Spray bottle filled with water, to deliver "rain" to the catchment basin
- Masking tape, to hold items in place, to secure the plastic sheet
- Sponge
- A few drops of food coloring
- Science notebook

Anchor or Investigative Phenomenon: The source and potential destinations for a glass of water in our school.

Driving Question: Where does our glass of water come from, and where does the water go?

	Teacher Does	Students Do
Engage ☑ Introduce object, event, phenomenon, problem, or question ☑ Build background knowledge ☑ Facilitate connections	To start the lesson, the teacher presents images from a local catchment, including images from a satellite view, local ground-based images, and maps of the area. After students document their observations, the teacher selects one student to come up and sort the sticky notes into an affinity diagram (https://asq.org/quality-resources/affinity). The student is asked to share his or her thinking and then the teacher facilitates a short class discussion in which other	Students look at the collection of images and identify observations, which they record on sticky notes. The students bring their post-it notes up to the front board to be shared. Then a student is selected to come up and sort the post-it notes into an “affinity diagram” where they group the notes in a way that makes sense to them. The student then shares his or her thinking with the class. Students then share what other patterns they notice in the observations and suggest

	students are encouraged to share what patterns they have noticed in the data and what they can add to the conversation.	other ways to sort the observations.
Explore ☑ Explore object, event, phenomenon, problem, or question ☑ Guided exploration with hands-on activities	The teacher introduces the activity and explains how the students will create a model of a local landform to explore how water moves in area catchments. Students may use either photo of the local catchments as inspiration or their own memory. (Teachers can offer students the option of researching local land formations or offer the students topographic maps if they are familiar with them to look at as well.) Students are presented with the materials list in the lab and consider what the materials provided represent in the real world. If students need support, the teacher may want to explain the purpose of a functions-like model. (A functions-like model is something that doesn't look the same as the real world but acts similarly. To help facilitate student understanding, students provide an example of a functions-like model we have seen in the past. Examples could include rubber band-powered cars, the water pump activity exploring groundwater, and others). As a class, students connect the resources provided with what they could represent in the real	Students begin by examining the visual resources provided or conducting their own research into a local landform area, such as a river valley or mountain range. They document their observations and thinking in their science notebook. After being introduced to the activity, a functions-like model, and the materials, students examine the resources for the modeling activity. Students turn and talk and discuss what they think each of the materials represents in the real world. (There are no set answers for this; how one uses a cup could vary. Most will likely see the spray bottle as rain. Teachers should use this opportunity to review the students' ideas on this model and identify which students may need more guidance. The teacher should not tell students what each item should be used for and remove students' opportunity for discovery.) After discussing the materials, students work in small groups to recreate a local land formation/catchment basin. They should start by drawing a cross-sectional view of the landform and a top-down view. Students then use the materials to create a close approximation and lay the

	world and make predictions of what they might represent. As students develop and document their functions-like models, the teacher cycles around the room and checks in with groups, providing minimal support as needed. In Nature Impact, students will explore the impact of humans on the environment. To introduce the topic, students should "play" with their setup to experiment and see the impact of human interactions on their watershed. The teacher could introduce this add-on to the whole group or to individual groups as they finish their prior work or split this into a second lesson. To introduce human interactions with the environment, the teacher passes out sponges and food coloring to the students and asks students what the sponges could represent and how we might use them to model real-life interactions with the environment. As students experiment with human interactions, such as creating a dam, erosion control walls, or other features, the teacher uses questioning strategies and minimal support to facilitate students working in their small groups. Finally, the teacher should introduce and model the idea of point pollution to the students by placing a few drops of food coloring on a sponge	plastic over the top to create the surface. They should label their diagram with the materials and the features represented in the real world. Next, students begin to experiment with their landforms model. Using the spray bottle, students should spray water on different points in the model and document how it moves using appropriate symbols on the diagrams. The symbols can vary, arrows may make the most sense, but encourage students to consider and use what makes sense for them. Students may also want to use different colors to symbolize different movements and if there is a divide in the catchments, they may want to use different colored arrows to represent the different catchments on their model. If there are divides in the landform model, students should add that to their diagrams to show that. Students finalize their catchment model diagram, adding a key to their diagram. Students use sponges to create obstructions and collection points for water. For example, the sponge could be used to stop water flow in a stream and create a dam, or it could be used to simulate hillside vegetation or other features created by humans. Students experiment with human interactions such as creating a dam, erosion control walls, or other features. They

	and placing the sponge onto the catchment model. This represents a point source of pollution; this could be something like a septic tank that is leaking from a house, a leaking underground tank at a gas station, a factory leaking pollution, or some other point source. The teacher supports groups as they explore this with minimal support and questioning strategies.	write down observations on the effect of introducing human environmental changes. (For example, a dam will lead to water building up behind it with less water flowing down the catchment. And, if the water builds up enough, it may move the dam and cause a flood downstream.) Students draw a diagram to support their observations. Finally, students use their model one more time to observe the impacts of the pollution on the model. The students write down their observations and add a diagram to support them.
Explain ☑ Explain understanding of concepts and processes ☑ Introduce new concepts and skills to seek conceptual clarity	The teacher cycles around the room while students are working on revising the problem definition and brainstorming ideas for their solution, asking probing questions that encourage students to consider how their new evidence either supports or refutes their initial thinking and encouraging them to make modifications to their solution based on this new evidence. The teacher should avoid directly connecting or telling students what to put into their problem or engineering solution. When students are sharing their problems and solutions, the teacher will encourage students to ask probing questions and justify their decisions in their choices and will ask students to use	After engaging with materials in each of the three activities, students work in small groups to use their notes/graphic organizers to add to the requirements/constraints of their engineering problem. After all students share their revised problem and solution, students should take time to re-evaluate their solution and make revisions based on feedback from the class and what other students shared about their own ideas.

	evidence to support their claims.	
Elaborate ☑ Build on or extend understanding and skill ☑ Apply concepts in new or related contexts		
Evaluate ☑ Self-assess knowledge, skills, and abilities ☑ Evaluate student development and lesson effectiveness		

Closing

To close the activity, the teacher asks students to consider the challenges and solutions to a point source of pollution. How might we find the source of the pollution? And what might happen if there are multiple sources, like in the case of septic tank systems? What are the challenges of cleaning groundwater? Students should record their thinking on an exit ticket to be provided to the teacher at the end of the lesson. The teacher should use this to help inform future instruction and research on the importance of groundwater and groundwater protection.

Differentiation Strategies and Resources

"Universal Design for Learning (UDL) is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn" (CAST, 2022). Taking time to reflect on prior instruction when planning for accessible, differentiated, and culturally responsive instruction for diverse learners and culturally diverse classrooms serves to identify ways to improve future instructional practices. The UDL Guidelines provide a framework for this reflection. The guidelines include three principles as ways to focus on variety and flexibility in instructional practices:

- Multiple Means of Engagement
- Multiple Means of Representation
- Multiple Means of Action & Expression

By examining instruction and instructional materials through the lens of each of these principles, teachers can identify and thus reduce or remove barriers to diverse learners.

Learning Opportunities	UDL Principle	Example Differentiation Strategies & Resources
Engage		
Students look at images of local landforms and	Multiple Means of Engagement	Provide choices • Allow students to select and research their own local landforms to find patterns.

catchment basins from different perspectives and share initial observations and patterns with the class.		Supply or activate background knowledge • Show a short video, objects, or photographs to activate students' background knowledge about local and regional landforms, the movement of water, and/or human impacts on the environment. • Invite students to share and make connections with their personal observations and cultural experiences as they explore and discuss local and regional landforms, the movement of water, and/or human impacts on the environment.
Explore		
Students build models of catchment basins and then use their models to simulate the movement of water through the basin. *Students document their model and how changes impacted the catchment basin.*		Provide options for accessing instructional activities and materials • Ensure that all students can physically access and interact with all activities and materials (e.g., table high enough to allow wheelchair access, an adaptation that allows access to print material, space to move to all areas in a classroom or lab, book holder, adapted keyboard, single switch, etc.). • Allow for differences in rate, timing, speed, and range of motion (e.g., Allow enough time for all students to process the question and formulate their responses; Allow enough time for all students to move from one activity to the next, or to perform a task.). Vary the ways for students to respond to questions or a task • Allow students to use a variety of ways to create their model (e.g., drawing, pictures, objects, multimedia). • Allow students to experiment with their functions-like models in ways that they choose. • Allow choices of how to collect and record data. (e.g., measure human impact to function-like models by taking before and after photos.) • Provide a variety of ways in which students can "write" to respond to questions. (e.g., traditional form of writing, with sentence starters, using pictures, etc.) Resources: Tactile Science Lesson: Using Play-Doh; Power-Assisted Writing for Science: Developing Expository Writing in a Multimedia Environment, ; Better Living Through Technology – Keyboards for People with Disabilities, Pathways to Reading to Learning for Students with Cognitive Challenges.

Explain		
Students add to their explanatory model the glass of water information about catchments and the storage of groundwater.		Support transfer and generalization of skills and knowledge • Revisit the anchor phenomenon, providing opportunities to review and practice prior knowledge and skills while making connections to new knowledge and skills.
		Support planning and strategy skills • Model and think aloud for students to demonstrate how to add information to their explanatory models such as diagrams, text, labels, and other features based on their work with the landform model.

Resources

- Can You Catch the Water? - Activity - TeachEngineering
  [https://www.teachengineering.org/activities/view/cub_earth_lesson2_activity3]
- Google Earth
  [https://earth.google.com/web/]
- Watersheds and Drainage Basins | U.S. Geological Survey (usgs.gov)
  [https://www.usgs.gov/special-topics/water-science-school/science/watersheds-and-drainage-basins]
- Interactive Database of the World's River Basins - Home (wateractionhub.org)
  [http://riverbasins.wateractionhub.org/]
- Colorful River Basin Maps – The Decolonial Atlas (wordpress.com)
  [https://decolonialatlas.wordpress.com/2017/04/18/colorful-river-basin-maps/]

Core Text Connections

- One Well: The Story of Water on Earth (CitizenKid): Strauss, Rochelle, Woods, Rosemary: 9781553379546: Amazon.com: Books
  [https://www.amazon.com/One-Well-Story-Water-CitizenKid/dp/1553379543]
- Every Last Drop: Bringing Clean Water Home (Orca Footprints, 4): Mulder, Michelle: 9781459802230: Amazon.com: Books
  [https://www.amazon.com/Every-Last-Drop-Bringing-Footprints/dp/1459802233]