H2 Oh! Watershed Investigation

(7 class periods)

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science

Grade Level: Middle School

Materials

- Water Footprint Worksheet
- Water Footprint Calculator
- US Population Worksheet
- Water cycle diagram
- Watershed diagram
- Writing utensil or device
- Explanation Handout (printed or electronically)
- Local watershed graphs (see explanation)
- Watershed model lab
- CER graphic organizer
- CER Sentence Starters
- CER rubric
- Google folder
- 1 Micro:bit with battery pack or USB cable
- 2 nails or metal probes (for the sensor)
- 2 alligator clip wires
- 1 small cup or container of dry soil
- 1 small cup or container of wet soil
  1 small cup or container of “mystery” soil (moist but unknown level)
- Computer with internet access
- Data recording sheet (or notebook)
- Access to MakeCode (https://makecode.microbit.org/)

STANDARDS

Next Generation Science Standards

- MS-ESS 3-4: *Construct an argument supported by evidence for how increasing in human population and per-capita consumption of natural resources impact Earth's systems.*

English Language Arts Standards | Common Core State

- CCSS.ELA-Literacy.WHST.6-8.1.b: Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
- CCSS.ELA-Literacy.WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- CCSS.ELA-Literacy.WHST.6-8.1 Write arguments focused on discipline-specific content.

Computer Science Teachers Association (CSTA) Standards

- **Level 2 (Grades 6-8)**
  - **Computing Systems**
    - 02 — Design projects that combine hardware and software components to collect and exchange data.
    - 03 — Systematically identify and fix problems with computing devices and their components.
  - **Data and Analysis**
    - 07 — Represent data using multiple encoding schemes.
    - 08 — Collect data using computational tools and transform the data to make it more useful and reliable.
    - 09 — Refine computational models based on the data they have generated.
  - **Algorithms & Programming**
    - 12 — Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.
    - 13 — Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs.
    - 17 — Systematically test and refine programs using a range of test cases.
    - 19 — Document programs in order to make them easier to follow, test, and debug.

LESSON OBJECTIVE(S)

Students will be able to construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

CAREER CONNECTION(S)

Mentor Background: Dr. Lauren Mancewicz: Dr. Mancewicz completed her bachelor's at Michigan Tech in environmental engineering; a subject which combined her love of the outdoors and interest in problem solving. She briefly worked for an environmental consulting company before returning to school for her masters in hydrogeology at the University of Nevada, Reno, with the intention of eventually getting her PhD and teaching at a college/university. While completing her PhD back at Michigan Tech, she was awarded the SMART Scholarship where she partnered with ERDC as her sponsoring facility. She still hopes to make it into the classroom at some point in her career, but now she is enjoying expanding her skills and project experience at ERDC as a Research Civil Engineer.

Her research uses groundwater model simulations to investigate groundwater quality and quantity problems. Most of her work uses models to study the impact of climate change on groundwater. For her PhD research, as well as work at ERDC, she used groundwater model simulations to look at the impact of sea level rise on fresh groundwater supply for small islands. Her work at ERDC also involves adapting groundwater modeling tools so that they can be used to solve emerging problems. For one project she is working to couple a geochemical model with a groundwater model to look at arsenic mobilization in Florida. She is also working to couple a surface water model with a groundwater model to better understand flood risks and the impacts of climate change.

STEM Careers: Civil Engineer, Hydrologist, Surveyors, Research Engineer, Architects, Computer and Information Research Scientist

ENGAGEMENT

Brief Description: Students predict their daily water usage, then use WaterCalculator.org to calculate their actual water footprint and compare the results.

Procedures:

To spark curiosity and connect science to students' daily lives, students begin by predicting how many gallons of water they think they use each day. They reflect on their habits and discuss whether they believe their water use is high, average, or low. After making their predictions, students visit watercalculator.org to complete the household water footprint quiz. This interactive tool guides them through questions about their home, lifestyle, and consumption habits to calculate their actual water usage. Students then compare their predicted and calculated results, analyze the difference, and reflect on ways to reduce their water footprint.

Brief Description: Students will explore how the U.S. population has changed over the last 50 years by collecting data from reliable websites, analyzing trends, and recording their observations to better understand factors that influence population growth.

Procedures: Record the population for each decade starting from 1970 to the most recent year available. Use your worksheet to enter the population figures and calculate the change in population between each decade. Once your data table is complete, look for patterns—identify whether the population is increasing steadily, rapidly, or slowing down over time. Use your findings to make a prediction about future population growth and support your reasoning with evidence from the data.

EXPLORATION

Brief Description: Students use a Micro:bit with a moisture sensor to measure and record soil moisture levels, helping them monitor environmental conditions.

Procedures:
For this activity, students can work in pairs, as well as groups of three and four. The **Estimated Time:** 30–40 minutes

Step-by-Step Instructions:

1. **Build the Moisture Sensor:**
    - Stick two nails into the soil about an inch apart.
    - Use alligator clips to connect:
        - One nail to pin P0 on the Micro:bit
        - The other nail to the GND (ground) pin
2. **Open the Code:**
    - Go to this website: https://makecode.microbit.org/projects/soil-moisture
    - Click **"Open Project"** to see the code.
    - This program measures the moisture level and shows a bar graph on the Micro:bit screen. The wetter the soil, the more bars will appear.
3. **Test It Out:**
    - Put the sensor into the dry soil. What do you see on the Micro:bit?
    - Now try the wet soil. What changes?
      Record the reading for each in your chart. (You can also press **Button A** to show the number.)
4. **Mystery Soil Challenge:**
    - Try the sensor in the "mystery" soil.
    - Based on your dry and wet tests, decide: Is this soil more wet or more dry?
    - Record your guess and the reading.
5. **Compare & Discuss:**
    - Talk with your group:
        - Which soil had the highest reading?
        - Why do you think that happened?
        - What are some places in real life where people need to know soil moisture?

Teacher Tips:

- Walk around and help with connecting wires and opening the website.
- It's okay if students are unsure—let them test and try again.
- Encourage students to use teamwork and talk about what they notice.
- Use printed data tables or digital charts to help students stay organized.

Optional Extension (for advanced or fast groups):

- Change the code to show words like "DRY" or "WET" instead of bars.
- Add a light or sound when the soil is too dry.
- Try different types of soil—sand, potting mix, clay—and compare.

EXPLANATION

Brief Description: Students will examine components of a watershed and what factors can impact a watershed.

Procedures:

Each student should receive an Explanation handout, they'll use the See, Think, Wonder side first.

Start with students completing a See, Think Wonder for graphs from your local watershed follow these steps to generate graphs for your area: Watershed Guide.

These can either be projected on the board or printed off for students to walk around the room and make notes as a gallery walk.

Once students have completed their chart on the graphs, have students share with an elbow partner. Then as a partnership choose 2 observations each for "See" and have partnerships share with the class, do the same with 1-2 think notes per partnership. Then have students flip over their paper and write one wonder in their box, it can be one from the front, one from a peer, or one based on discussion of the first two sections.

Go over key vocabulary with students, they will complete the middle section of the handout:

Watershed: area of land that channels rainfall, snowmelt, and runoff into a body of water

Precipitation: Rain, snow, sleet, hail; any type of weather falling from the sky

Runoff: draining away of water

Then share an image of a watershed and walk students through the cycle of water within the diagram. Then post the USGS Watershed diagram and have students decide which aspects are precipitation and which are runoff. Then have students brainstorm factors that impact their watershed- positively and negatively on their handout.

Optional extension: if you have a group of students you want to pull research data to create their own graphs, you can use these Task Sheets to help them plan out their research.

ELABORATE

Brief Description: Students will investigate how water moves through a watershed and how human activities affect its health.

Procedures: To begin the watershed lab, each team will take a piece of white typing paper and gently crumple it to create a model that represents the elevations found in a real landscape. This crumpled paper will act as a topographical map of your watershed. Using permanent markers, outline and color specific features: draw mountains in black or brown, agricultural areas in green, water bodies like rivers and lakes in blue, and urban areas in gray. Next, the student lab groups will determine how many distinct watersheds are present in your model by observing how the ridges and valleys might guide water flow. Then, using a washable orange marker, represent pesticide use by marking dots and streaks over the green agricultural areas. Carefully student teams will tape the four corners of the crumpled paper onto a larger piece of card stock, ensuring that the paper remains raised in areas to preserve elevation differences. Once the model is assembled, students will simulate rainfall by spraying water gently over the paper using a spray bottle. They will watch as the water flows down the slopes, carrying the orange pesticide marks into streams, rivers, lakes, and eventually the ocean. Students will record observations about how the water moved and where the pollutants ended up in their notebooks. Then they will answer analysis questions.

EVALUATION

Brief Description: For the evaluation, students will write a scientific argument using the Claims, Evidence, and Reasoning (CER) framework to explain how increasing human population and natural resource consumption impact watersheds and Earth's systems.

Procedures:

1. Put students in groups of three.
2. Present students with the guiding question:

"How do increases in human population and per-capita consumption of natural resources impact Earth's systems?"

Clarify that their task is to construct a scientific argument using the **CER** format.

3. Review CER Expectations (with the rubric)

- **Claim**: A one-sentence answer to the guiding question.
- **Evidence**: Specific data from lab activities (e.g., Watershed model), population databases, or water usage graphs.
- **Reasoning**: An explanation of how the evidence supports the claim using relevant science concepts (e.g., pollution movement in watersheds, impact of urbanization on water systems).

4. Have students review their watershed model lab observations, US population trends, Micro: Bit lab observations, and water usage information. Have students highlight the most relevant pieces of evidence. Then fill out the CER graphic organizer.
5. Give students CER sentence starters to help students draft their arguments.
6. From the graphic organizer have students draft their arguments. Have student groups exchange arguments and give constructive feedback.
7. Have students finalize their CER writing.

Claim-Evidence-Reasoning (CER) Example

- Claim: Human population growth increases pressure on Earth's systems.
- Evidence: Satellite images show expanding urban areas and decreasing forests.
- Reasoning: As population grows, more natural resources are used, leading to deforestation and habitat loss.

Claim: Human activities like ____ affect the watershed by _____.

Evidence: In our model, we observed _____.

Reasoning: This shows that ____ because _____.

Argument Starters Example

1. As the human population grows, the demand for ____ increases, which leads to ____."
2. When people use more ____, it causes ____ in the environment."

Extension

After students complete their CER, show them the following video, Future of Water - Retro Report, ask students if the information from the video changes anything in their CER. Have them answer the following sentence stem "In the video, I learned that _____. This supports the idea that human actions such as _____ affect Earth's systems because _____.

Then ask why water is important. Then watch the video, Water Changes Everything. Ask if the information in the video changes their CER. Have students answer the sentence stem: The global water crisis shows that _____. In the video, Water Changes Everything, _____. This strengthens the argument because it parallels our model's findings _____and highlights the human consequences of water mismanagement.

REFERENCES

- Micro:bit Makecode: https://makecode.microbit.org/
- Platform: https://hydroclimate.ornl.gov/
- Soil Moisture with the Micro:bit: https://makecode.microbit.org/projects/soil-moisture
- Watershed Explanation: https://www.fisheries.noaa.gov/new-england-mid-atlantic/habitat-conservation/what-watershed#:~:text=A%20watershed%20is%20an%20area,to%20think%20of%20a%20bowl.
- Watershed Image: https://www.nextgenscience.org/sites/default/files/MS-ESS_Watershed_Study_version2.pdf
- World Bank https://data.worldbank.org/indicator/SP.POP.TOTL?locations=US
- Macrotrends https://www.macrotrends.net/global-metrics/countries/usa/united-states/population
- United States Census https://www.census.gov/popclock/
- Future of Water - Retro Report
- Water Changes Everything