5E STEM Unit Plan Getting to Know Your Watershed

(2 weeks)

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science

Grade Level: Middle or High School

Materials

- For this activity, you will need a computer with internet. You will review the following with your students: Getting started with ArcGIS StoryMaps.
- Students each need access to a computer and the internet.
- If not already available, work with your IT department to help your district get the ArcGIS K-12 Bundle. This FREE software provides students with opportunities to work within the ArcGIS system, providing them with real-world STEM experience and aiding in their 21st-century skills development.
- Maps of your local region
- Maps of the U.S. and/or student-selected countries
- Paper, markers, spray bottle (or dropper)

STANDARDS

Next Generation Science Standards

- MS-LS21: MS-LS21 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, the occurrence of natural hazards, and climate changes have influenced human activity.

Mathematics Standards | Common Core State Standards

- CCSS.MATH.CONTENT.7.RP.A.2: Recognize and represent proportional relationships between quantities.

- MP.4 Model with mathematics.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.SL.11-12.1.A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
- RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)

Computer Science Standards

- CSTA 2-DA-09: Collect data using computational tools and transform the data to make it more useful and reliable.

LESSON OBJECTIVE(S)

Students will investigate the watershed in which they live and compare watersheds around the United States!

So that they can better understand the importance of watersheds and what they can do to maintain them.

Students will know that they got it when they complete the Planning Your Watershed Story Map Worksheet and make an ArcGIS StoryMap using the ArcGIS Personal Watershed Story Checklist.

CAREER CONNECTION(S)

Mentor Background: Dr. Lauren K. Mancewicz is a Research Civil Engineer in the Hydrologic Systems Branch at the Coastal and Hydraulics Laboratory with the U.S. Army Engineer Research and Development Center (ERDC) in Vicksburg, MS. She completed her Bachelor's degree at Michigan Tech in Environmental Engineering, a subject which combined her love of the outdoors and interest in problem solving. Dr. Mancewicz briefly worked for an environmental consulting company before returning to school to pursue her Master's degree in Hydrogeology at the University of Nevada, Reno, to eventually earn her PhD and teach at a college/university. While completing her PhD at Michigan Tech, she was awarded the SMART Scholarship, where she was partnered with ERDC.

Her research uses groundwater model simulations to investigate groundwater quality and quantity problems. Most of her work uses models to study the impact of long-term extreme weather events on groundwater resiliency. For her PhD research, as well as work at ERDC, she used groundwater model simulations to look at the impact of extreme sea level events on fresh groundwater supply for small islands. Her work at ERDC also involves adapting groundwater modeling tools to address 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.

STEM Careers:

Environmental Engineer

Energy Engineer

Water Quality Specialist

Lab Technician

ENGAGEMENT

Brief Description: Students will explore watersheds and their importance through a small simulation and Think-Pair-Share.

Procedures:

- **Time frame**: 15 minutes

1. Ask students, **"Where does your drinking water come from?"** and **"Where does water move when it rains?"** (*whole class questions).*
2. In groups, give students a piece of paper *(teacher action).* Ask students to crumple and open the paper and place it on a tray *(student action).*
3. Tell students that this paper represents Earth's surface, complete with mountains and valleys.
4. Give students 3 markers of different colors. Ask them to draw 3 different "neighborhoods" (each with a specific color) in different locations on their paper.
5. Simulate "rain" *(teacher action*): use a dropper or spray bottle to add water to their paper until the colors begin to bleed and mix.
    a. See video example
6. Ask students to observe where the water collected at the bottom of the tray *(small group discussion).*

Formative Assessment: Think-Pair-Share

7. Give students 2-3 minutes to jot down their ideas individually about what a "watershed" is and why it is important, based on this simulation *(Think).*
8. Give students 30 seconds to converse with a partner about their answer *(Pair).*
9. Ask each partner to share their answer with the class *(Share).*
10. Emphasize (if not already stated by student(s)):
    a. *"All that is shown (highest peaks to lowest basins) on the paper is part of a single watershed.*
    b. *All that happens on land (including in neighborhoods) connects to our watersheds and thus the quality of our water. This is why we must keep our landscapes clean and healthy!"*
11. Have students clean their tables.

Adaptations:

- **For Individual Learners:**
    - Give students their own piece of paper and cup of water to simulate this activity.
    - Instead of providing paper, give students a piece of aluminum foil so that they can repeat the simulation multiple times (self paced)
    - Ask students to reflect using personal prompts (can be in worksheet format).
- **For Virtual Learners:**

- Provide a demonstration of the simulation through the webcam.
- Show students a short video of a real watershed ("What is a Watershed?" by Battle River Watersheds) and discuss water movement as a class.

- **Extension:**
  - Give students salt, pepper, or glitter after the first few "mists" to simulate how pollution can travel and spread through a watershed.

Background Information: What is a watershed? *A watershed is an area of land where all the water drains to a common outlet, such as a river, lake, or ocean. A watershed acts like a funnel, collecting precipitation (rain and/or snow) and directing it towards a single location.*

Educators should also be aware of their own watershed and the areas in which it extends.

To learn more about watersheds, visit: https://education.nationalgeographic.org/resource/watershed/

EXPLORATION

Brief Description: Students will plan a Personal Watershed StoryMap using guiding instructions.

Procedures:

- **Time frame**: 45 minutes

1. Show students the **examples of Watershed StoryMaps** created by other educators and students *(include a StoryMap that involves your local watershed if not listed in the resources below)*:
   a. Amazon River Watershed *(features maps from different sources)*
   b. Florida Watersheds *(features map points/trail to follow)*
   c. Louisiana Watersheds *(features zoom in/out map)*
   d. Chesapeake Bay Watershed *(features highlighted regions and statistics)*
2. Give students **2 minutes to explore** any of the four resources.
3. In small groups, have students **discuss observations** about the StoryMaps they explored:
   a. What they liked
   b. What they did not like
   c. Similarities between StoryMaps
   d. Differences between StoryMaps
   e. What they think was the intended purpose and/or audience of the StoryMaps
4. Tell students **they will be creating their own StoryMap** to inform others about a specific watershed that they may choose.
   a. Remind students that this can be their local watershed or watersheds from different states; they just have to have a reason for picking this watershed.
5. Tell students that they may **work individually or in pairs** to complete the **Planning Your Personal Watershed StoryMap (worksheet)** (**Formative Assessment)**
6. Once completed, help students sign up for a FREE ArcGIS account and review Getting Started with ArcGIS StoryMaps

Background Information: Educators must be aware of how to use StoryMaps, including setting up an account, exploring possible features, and consolidating student StoryMaps into a single StoryMap. It is best to have an example StoryMap that relates to the area of the school or the educator.

Adaptations:

- **For Individual Learners:**
  - Students can review each StoryMap individually and create their own StoryMap alone if they choose.
- **For Virtual Learners:**
  - Briefly share your screen and review one of the StoryMaps as a class. Ask students the same questions (similarities, differences, what they liked or did not like, etc.) as a class.
  - Separate students into Breakout groups to discuss the StoryMaps that they had explored.
- **Extension:**
  - Ask students to brainstorm other topics related to their chosen watershed that would make their StoryMaps more interesting for the reader(s):
    - For example, students can research how human activities affect the specific watershed that they have chosen.

EXPLANATION

Brief Description: Students will use a variety of resources (ArcGIS, Google Earth Timelapse, USGS Streamstats, and Model My Watershed) to complete guided research about their chosen watershed location. They will create StoryMaps connecting all of this information in a cohesive, published product!

Procedures:

- **Time frame**: (at least 30 minutes per resource x 4 resources) + 120 minutes for StoryMaps Creation = about 4 hours

ArcGIS

1. Show students the ArcGIS map with USGS overlay for your state.
2. Explain what a HUC means *(see Background Information for this section)*
3. Ask students to **choose the HUC level they would like to work with** concerning their chosen StoryMaps location.
4. Show students how to **take a screenshot** of the ArcGIS map with USGS overlay with their HUC level.
   a. *Remind students to include this screenshot in their StoryMaps and why they chose this HUC level*
   b. *Students can also use the Climate-Hydro Analytics Platform to research their selected watershed.*

Google Earth Timelapse

5. Show students the Google Earth Timelapse for the area surrounding your school
6. Ask students to **type their chosen location** into the Google Earth Timelapse and **take at least two screenshots** that show how their location changed over time
   a. *Remind students that:*

i. *If differences are difficult to see, they should zoom in further and watch until they can see small details (usually expansion of human development).*
ii. *They can slow the timelapse to x0.25 if needed.*

Google Earth Timelapse

7. Give students the StreamStats Exploration Sheet
8. Explain to students that "USGS StreamStats is a web-based tool for delineating watersheds and estimating streamflow statistics for ungaged locations."
9. Tell students to **go to the StreamStats website.**
10. Show students how to **select their state/region and zoom in** to an area of interest.
11. Show students how to **delineate a watershed** by clicking on a stream.
    a. *StreamStats will calculate the contributing drainage area and estimate flow statistics. Here is a how to use it guide:* https://www.usgs.gov/streamstats/how-guides

Model My Watershed

12. Show students Model My Watershed.
13. Have students **type their chosen location** in the search bar (top right)
14. Show students how to explore within the "**Layers**" box, specifically:
    a. "**Coverage Grid**" and the transparency bar for Land Use Cover during various years
    b. "**Basemaps**", more specifically "Topography" and "Terrain"
15. Tell students to click "**Delineate a Watershed**", click "**Continental U.S.**", then click the area that matches the maps they had chosen in previously used resources.
16. Show students that **they can explore/analyze data** about:
    a. *Streams*
    b. *Land Use/Cover*
    c. *Soil Group Distribution*
    d. *Terrain (Elevation and Slope %)*
    e. *Climate (Mean Precipitation and Temperature)*
    f. *Number of Farm Animals*
17. Have students select the "**Model**" tab on the top left, then select "**Site Storm Model**". Inform students that this **generated hypothetical data** using a model to **show the results of a 24-hour hypothetical storm event** based on:
    a. *Runoff*
    b. *Water Quality*
18. Show students that they can change the "**Precipitation**" using the slider bar,
19. Show students that they can also click "**Add changes to this area**" to edit "**Land Cover**" and "**Conservation Practices.**"
20. Tell students that they **must include a graph in their StoryMaps from Model My Watershed**, and they can either:
    a. Screenshot and interpret their 24-Hour Hypothetical Storm Event Graph
    b. Choose one data set to download from the "**Analyze**" section and graph using Excel
        i. *Show students the video if they need help creating a graph from a data set!*
21. Remind students to **screenshot any maps they would like to use in their StoryMaps before exiting the program**.

Formative Assessment: creation of **StoryMaps** individually or in pairs.

22. Tell students to sign in to StoryMaps and click "**+New Story**" on the top right corner of their screen.
23. Click "**Start from Scratch**".
24. Decide on your **Title**.
25. Under the title, **add a short description** (1-2 sentences) of your StoryMaps
    a. *For inspiration, see "Explore" activity examples!*
26. Tell students to click "**Add cover image or video**" to insert an image of their location
    a. *Students can use one of the saved screenshots (see previous instructions) as the cover image if they prefer.*
27. Show students how to format the layout of their StoryMaps by clicking "**Design**". They can change:
    a. "**Cover view**" (half page vertically, half page horizontally, full screen)
    b. "**Navigate**" to allow readers to navigate different sections of the StoryMaps
    c. Theme (color)
28. Tell students to **add content by clicking (+)** to add sections to their StoryMaps:
    a. Include **subheadings** and **main text**
    b. To add images, select "**Image**" and upload
    c. To add maps you have **already created through ArcGIS,** select "**Map**"
        i. *Students can change settings by removing layers, zooming in/out, etc.*
    d. Select "**Map Tour**", then "**Start with a feature service**" to use previously made map layer
    e. Select "**Start from scratch**", then:
        i. "**Guided**" to create a map that has sequential order (numbered)
        ii. "**Explorer**" to create a map with no specific order
    f. Select the **pencil symbol (edit)** to add a location:
        i. *Students can zoom in/out or type and enter the location into the search bar*
    g. To add a video:
        i. Stored from computer files: select "**Video**"
        ii. Linked from a website: select "**Embed**" and paste the link
        iii. *Videos can be resized as students prefer!*
    h. Select "**Audio**" to add music:
        i. Stored from computer files: select "**Upload**"
        ii. Linked from a website: select "**Embed**" and paste the link
    i. Select "**Image gallery**" to add multiple images for readers to browse:
        i. To edit image layout, select the settings (gear symbol) button on the top of the image gallery:
            1. Equally sized boxes: choose "**Dynamic squares**"
            2. Random sized boxes: choose "**Jigsaw**"
            3. Scroll bar previews: choose "**Filmstrip**"
29. Remind students that the **box at the bottom of the screen ("Sidecar")** allows students to **scroll, view, and rearrange** each section of their StoryMaps
30. Remind students that these are instructions for how to use *basic* features in StoryMaps. If they would like to review **more advanced features**:
    a. How to create an ArcGIS StoryMap Video

b. Getting started with ArcGIS StoryMaps Reading

31. Give students time to play with StoryMaps, include all gathered information about their watershed, preview their StoryMaps (select "**Preview**") and publish (select "**Publish**") their work. Here is a sample StoryMap.

Background Information: What is an HUC? *Educators must know that HUC stands for **Hydrologic Unit Code** and that it is a hierarchical system developed by the United States Geological Survey (USGS) to identify and classify watersheds in the United States. They can compare HUCs as "postal codes" for water. Each HUC represents a specific drainage basin, and the numbers in the code indicate the size and level of detail of the watershed.*

- ***HUC-2** represents major basins (e.g., the Missouri River Basin).*
- ***HUC-4** represents sub-basins.*
- ***HUC-6** represents accounting units.*
- ***HUC-8** represents cataloging units (often used for watershed planning).*
- ***HUC-10** and **HUC-12** represent increasingly smaller and more detailed watersheds.*

Adaptations:

- **For Individual Learners:** for students who need more guided learning in "Model My Watershed", provide students with the Model My Watershed Exploration Sheet and embedded video
- **For Virtual Learners:** Give students links to videos on how to use each resource:
  - ArcGIS Map with USGS Overlay
  - Google Earth Timelapse
  - USGS Streamstats
  - Model My Watershed Video Tutorials:
    - Mapping
    - Modeling Pollutants over a Day
    - Modeling Pollutants over a Year
  - How to Create an ArcGIS StoryMaps
- **Extension:**
  - Students can click "Compare" in "Model My Watersheds" to show the difference between current conditions, predominantly forested conditions, and any variables they choose to change in "Land Cover" and "Conservation Practices". This difference can be included in their StoryMaps!
  - Students can also explore and simulate water and pollutants in "Model My Watersheds" by clicking "Details" → "Model (edit)" → "Model" → "Watershed Multi-Year Model."
    - This simulates the averages of many variables per month (runoff, precipitation, etc.) and per year (nitrogen, phosphorus, sediment)

ELABORATE

Brief Description: Students will interview someone else (can be a classmate, teacher, family member, etc.) about their experience with watersheds. Students will take a photograph related to the watershed near their school.

Procedures:

- **Time frame**: 45 minutes

1. Remind students that their **StoryMaps will be linked together** (example here) for all classes to see and learn!
2. Give students the Personal Watershed Interview Protocol
3. Ask students to **interview someone** using the protocol. This can include, but is not limited to
    a. *Classmate or Friend*
    b. *Teacher or other Staff Member*
    c. *Family member*
4. Ask students to **take a photograph related to the watershed around school.**
5. Give students the Personal Watershed Reflection
6. Ask students to **write a caption for their photograph** based on their reflection.

Background Information:

Sharing a personal watershed story, especially in the context of environmental advocacy, offers several benefits:

- Emotional connection: Stories create empathy and understanding. By hearing about individual experiences, listeners can connect with environmental issues on a deeper, more emotional level, making the abstract feel relatable.
- Humanizing the issue: Personal stories put a human face to these challenges, showing how they affect people's lives and communities.
- Inspiring action: Stories can motivate individuals to change their own behaviors and support broader environmental initiatives..
- Building a sense of community: Sharing stories fosters a feeling of shared experience and purpose, connecting people to the cause and encouraging collaborative efforts.
- Empowering individuals: A personal watershed story can highlight an individual's agency and their potential to make a difference, both locally and globally, which can be empowering for others who are also seeking to take action.

Adaptations:

- **For Individual Learners:** For students who may not be comfortable (or have access to) interviewing someone, provide the Watershed Reflection Interview Analysis.
- **For Virtual Learners:** if students do not have access to interviewing someone, place them in Breakout groups to allow for pairs to interview one another virtually.
- **Extension:** Give students the My Watershed Pledge Worksheet
    - *Display their Watershed Pledge around the classroom!*

EVALUATION

Brief Description: Students will evaluate their Storymap creation using a checklist and complete a scaffolded reading about Dr. Mancewicz's life and research.

Procedures:

1. Provide students with the ArcGIS StoryMaps Checklist to ensure their project meets all necessary criteria.

Formative Assessment: Exit Ticket

2. Give students the Groundwater Research Reading (based on the "Career Connections" section and Dr. Mansewicz)
3. Collect all worksheets.

Need help?

- ❏ How to capture a screenshot PC
- ❏ How to capture a screenshot Mac
- ❏ StreamStats Video Tutorial
- ❏ StreamStats Exploration Sheet
- ❏ Model My Watershed Video Tutorials:
  - ❏ Mapping
  - ❏ Modeling Pollutants over a Day
  - ❏ Modeling Pollutants over a Year
- ❏ Model My Watershed Exploration Sheet

REFERENCES

- Georgia Southern University Swamp2Gulf Teacher Professional Development https://docs.google.com/presentation/d/16na4XyhqqxiJyLYtTtyCCFJkrMkuX9i1NKRpWO25vBw/edit?slide=id.p#slide=id.p
- ESRI/ArcGIS: https://www.esri.com/content/dam/esrisites/en-us/arcgis/products/storymaps-2019/Planning%20your%20next%20story%20map.docx
- Climate Generation: https://climategen.org/blog/environmental-justice-narratives-personal-stories-from-the-field/
- Oak Ridge National Laboratory https://hydroclimate.ornl.gov/
- AI