

Tides: Understanding Impacts on Human Activity Around the Globe

Developed by Nessa Goldman – City, State – #th Grade Course (2023-2024)

Guiding Questions

- How might tides impact human activity in different parts of the globe?
- Are there connections between tidal patterns and sea surface temperatures?
- What impact, if any, might high and low tides have on sea surface temperatures?

Placement in Curriculum

Note from the author: I started with an overall introduction to Earth and the Solar System, starting with the Big Bang and the theories that support it. That led into the theories behind the creation of our moon, and some background information on the moon and how it is both impacted by, and impacts gravity on Earth. With this basis for the phenomenon of how the moon impacts our tides, I started with BIO.

Learning Objectives

- Students will explore how high and low tides vary in different parts of the world.
- Students will compare and contrast visual datasets depicting tidal variations, sea surface temperatures, and shipping routes.
- Students will look for patterns and determine if there is a correlation between the datasets, and what that correlation may imply.

Standards Alignment:

Disciplinary Core Ideas:

- ESS1.A: Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.
- ESS2.C: Global movements of water and its changes in form are propelled by sunlight and gravity.
- ESS2.D: The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

Crosscutting Concepts:

- Patterns
 - Graphs, charts, and images can be used to identify patterns in data.
 - Patterns in rates of change and other numerical relationships can provide information about natural systems.
 - Patterns can be used to identify cause-and-effect relationships.

- Models
 - Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.
 - Models are limited in that they only represent certain aspects of the system under study.

Science and Engineering Practices

- Developing and Using Models
 - Evaluate limitations of a model for a proposed object or tool.
 - Develop and/or use a model to predict and/or describe phenomena.
- Analyzing and Interpreting Data
 - Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.
 - Distinguish between causal and correlational relationships in data.
 - Analyze and interpret data to provide evidence for phenomena.
 - Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).
 - Analyze and interpret data to determine similarities and differences in findings.

Advice for Educators

Don't be intimidated by the Observation & Discussion facilitation approach or their familiarity with visual datasets. Application of this unit takes practice, but getting it "wrong" can be informative, and your students will most likely enjoy it all the same. For teachers of younger students (6th grade) to give some more scaffolding, maybe even present an example of both fenceposts and data sketches before launching the activities. If I were to do it again, I might use the parking lot later, when the relevant data sketches are being introduced. I think that would lead to more relevant questions to further the lesson and the greater unit they are a part of.

Materials

- Computer and LCD Projector to display artwork and dataset
- (Optional) Tablets for students with SOS Explorer mobile app installed
- Observation & Discussion Slide Deck: [PowerPoint](#); [pdf](#)
- Fencepost Slide Deck: [PowerPoint](#), [pdf](#)
- Data Sketches Slide Deck: [PowerPoint](#); [pdf](#)
- Featured Artwork: [Boats in Mousehole Harbour Cornwall England](#)
- Featured Data: [Global Volcano Locations](#)
- Sticky notes/easel/dry erase boards for recording questions
- Long strips of cardstock paper approximately 10 inches long by 2 inches across so you can have 5 squares of 2 in. x 2 in. ([Template](#)). Dimensions and shape can be changed based on your circumstances/resources/space.
- String and clothespins or tape
- Scissors, markers, colored pencils, erasers
- Rulers
- Paper clips
- Scratch paper
- 11" x 17" vellum tracing paper
- Handouts:
 - [Fencepost Survey Questions](#)
 - Optional: [Data Visualization Choices Worksheet](#)
 - [Design Tools Guide](#)
 - Additional Mapped Datasets
 - [Shipping Routes](#)
 - [Sea Surface Temperature](#)
 - [Tidal Elevation](#)
 - [Data Sketches Student Worksheets](#)

STEP 1 – Observation and Discussion

Part 1 – Art

1. Share norms for the discussion and briefly introduce the process to the students.
2. Project the **Featured Artwork** so that it's visible to the entire class.
3. Invite students to observe the image silently for 1-2 min.
4. Have students journal or write down initial ideas during this time.
5. Tell students: *“Let’s take a moment to look at this picture together.”*
6. Invite as many students as possible to share their ideas about what the image shows, using the following prompts/facilitation sequence (10-15 minutes)
 - a. Invite Student Ideas: *What’s going on in this image?*
 - b. Gesture: As each student is speaking, use your hand, mouse, or pointer to gesture to parts of the image that they are referencing so that the whole class can see.
 - c. Paraphrase: Repeat the student’s observations using different language, taking advantage of opportunities to introduce appropriate vocabulary and without validating/invalidating their ideas.
 - d. Ask for Evidence: *What do you see that makes you say _____ ?*
 - e. Invite More Ideas: *What more can we find?*
7. Thank the class for participating in the experience and for sharing their observations.
8. (Optional) Have students share in pairs any additional thoughts or observations (5 minutes): *“Now that we have all looked together, I know there are still more ideas. Turn to a person sitting next to you and share more or share something you didn’t share with the larger group.”*

Part 2 – Data

1. Tell students that now you are going to use the same approach and observe a mapped dataset. **It is important you do these observation sessions back-to-back. The observation and discussion with the art image may be more accessible to many students and encourages those that do not usually speak up or that are uncomfortable with science/data to participate. The art image may be more engaging and personally relevant, getting the students primed in the approach of observing and talking.*
2. Project the **Featured Data** WITHOUT the legend. Ask for 1 minute of silent observation time and 2-3 minutes of journaling time. Use the map: **Title – WITHOUT Legend**.
3. (If this happens on the next day) Review the norms for discussion again.
4. Invite as many students as possible to share their ideas about the visual patterns they see in the data visualization, using the following facilitation sequence and prompts (~5 minutes)
 - a. Invite Student Ideas: *What’s going on in this image?*

- b. Gesture: As each student is speaking, use your hand, mouse, or pointer to gesture to parts of the visualization that they are referencing so that the whole class can see.
 - c. Paraphrase: Repeat the student's observations using different language, taking advantage of opportunities to introduce appropriate vocabulary related to the phenomenon, visualization, and/or data (e.g., scale, hemisphere, latitude/longitude, trend, variability) and without validating/invalidating their ideas.
 - d. Ask for Evidence: *What do you see that makes you say _____ ?*
 - e. Invite More Ideas: *What more can we find?*
5. Project the **Featured Data** WITH the legend now, so that it's visible to the entire class.
6. Invite students to look again at the data visualization that now includes a legend, providing ~1 minute to silently and independently observe.
7. Invite as many students as possible to share their ideas about the visual patterns they see in the data visualization, using the following facilitation sequence and prompts (~5 minutes)
 - a. Invite Student Ideas: *Now that you see this addition, how has your thinking changed?*
 - b. Gesture: As each student is speaking, use your hand, mouse, or pointer to gesture to parts of the visualization that they are referencing so that the whole class can see.
 - c. Paraphrase: Repeat the student's observations using different language, taking advantage of opportunities to introduce appropriate vocabulary related to the phenomenon, visualization, and/or data (e.g., scale, hemisphere, latitude/longitude, trend, variability) and without validating/invalidating their ideas.
 - d. Ask for Evidence: *What do you see that makes you say _____ ?*
 - e. Probe for more: *What do you think [visual feature you observed] might mean?*
 - f. Invite More Ideas: *What more can we find?*
 - g. If students are having difficulty providing new observations, try asking:
 - i. *What do you wonder?*
 - ii. *What jumps out at you? What do you see first?*
 - iii. *Does anything in this visualization seem unusual or unexpected to you?*
 - iv. *What's interesting to you? What is familiar to you?*
 - v. *If you could talk to the scientists who made this, is there anything you'd want to ask them?*
8. Thank the class for participating in the experience and for sharing their observations.
9. (Optional) Have students share in pairs any additional thoughts or observations. Ask them to think about additional questions they have which you will record in the next section (~5 minutes)
10. Tell students: *"Now that we have all looked together I know there are still more ideas. Turn to a person sitting next to you and share more or share something you didn't share with the larger group. Think about additional questions you might have. We will discuss these questions next as a class."*

11. Develop a list of questions that were generated and ask for more questions. Teachers should interject questions that would facilitate the investigation/learning of content if the students have not yet brought it up. Ask: *What are you curious about? What questions do we have? I'm curious why the patterns are...?*
12. Create a digital (e.g., Google Docs) parking lot with a question list or use sticky notes and tell students you will revisit these questions later in the program. Another option is for the teacher to aggregate the questions into 5-10 questions for a Driving Question Board that can be displayed in the classroom during this unit.

STEP 2 – Bridging Approach: Fencepost Activity

1. Give each student the **Design Tools Guide** handout.
2. Tell students: *“Data like we just saw in the Mapped Data exercise comes from a variety of sources – individuals can collect data at a local level or one point in time and then combine those observations/data to show data over time or over a larger spatial area. We can also collect data with satellites which provide large areas of remotely sensed observations and can even provide global pictures of data/science phenomena. People use symbols to convey information in a simple and effective way. Symbols are an important part of maps and can represent a range of different types of data. Symbols are described in a legend – a box or other place on the map where there is a key that says what each color of symbol means. Let’s look at different ways we can represent data.”*
3. Review the **Design Tools Guide** with students - ask the students to reflect on the previous activity comparing maps about which design tools were used/chosen and why.
4. Give each student a strip of paper that is divided into 5 numbered squares (You can use the **Template** provided).
5. Hand out the **Fencepost Survey Questions**.
6. Read through each question and discuss with the class which design tool would be best, and then determine which color, symbol, shading, etc. would work for that question. Tell the students that they can’t use each design tool more than once in the survey. ****Note:** This can be a little time-consuming, but it’s a great way to give students a chance to think carefully about design tools, and to take ownership over the data.**
7. Have the students answer the questions on their strip using the colors/symbols that correspond to their answer choice. Instruct the students to work their way through the questionnaire and respond to the first question in the first block and so on. For some questions, students can color, draw or collage with images from the magazines. For other questions, a written word or phrase is ideal.
8. After all students have finished their responses, line all the students’ work side by side as a “fence post” (tape them on a wall or attach to a string) so that you can see trends across the class. Alternatively, you can spread them out onto a table so the strips can be moved around.
9. Invite the students to silently observe the ‘fence posts’ for 1 minute.
10. Invite discussion or written responses on the following:
 - a. What patterns do you notice?
 - b. What do the patterns tell us about our collected data?
 - c. Do you think the patterns would be different in other locations/with other ages/more people?
11. Optional Classwork or Homework: Give students the **Data Visualization Choices Worksheet** to do in class or for homework.

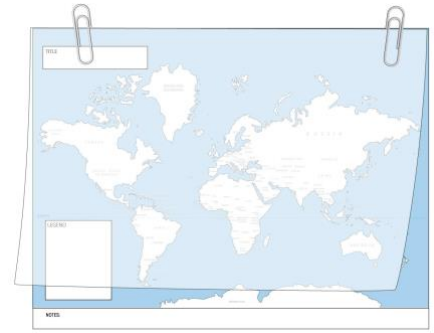
STEP 3 – Data Sketches: Making Data Visual

Have students sit in groups of three or four.

Part 1 – Plan & Sketch

1. Give each student a printed copy of the original mapped data (with legend) from the Observation and Discussion with Data session along with the **Design Tools Guide** handout.
Note: By now the students should be familiar with both the original map and the design tools. It is important to keep referring to the design tools so students become familiar with using them.
2. Explain: “Remember how we looked at the different mapped data representations and how we used the Design Tools to come up with our own symbols to answer the questions in the Fencepost Activity? Today we are going to discuss mapped data further and practice using these tools ourselves by creating our very own map legends with symbols, colors, marks...”
3. First, let’s remind ourselves about our map from earlier in this lesson. Invite discussion about the following questions regarding the printed map you have handed out (10 minutes):
 - What design tools were used to draw the data on this map?
 - What is included in the legend?
 - Why do you think they chose this particular design tool for this set of data?
 - While some tools are better for representing sets of data, there is no right or wrong tool. Are there different design tools we could use to represent this data? *Look through the handout and discuss what some good choices might be for this topic.*
4. Give each group 2-3 **Additional Mapped Datasets** related to the topic so that each student has a different map to work with. You can have students choose or you can assign datasets to different students based on ability or interest. Just make sure that someone from each group is assigned to the original **Featured Data**.
5. Invite students to silently observe their maps for a few minutes and have them spend a little time making sure they understand what the data is trying to show. (5 min.)
6. Ask the students to decide within their group how they might represent the data in each of the three maps in a different way than it is currently while using three distinct design tools (i.e., color, symbols, scale) from their **Design Tools Guide** for the three maps. Have students work on developing new legends for each map using scrap paper, pencils, and markers (10 minutes)
7. Ask each student to choose one of the maps. Hand out **Data Sketches Student Worksheet 1** and the **Base Map Template**.

8. Have students paperclip a sheet of tracing paper over the map template and follow the prompts on worksheet 1 (*please show an example of what they are being asked to do*). This worksheet will guide them through beginning their map. *The map template provided to be used as a guide under the tracing paper is important because it forces each student to create a map that is on the same scale as the others so that these maps can be easily layered together in the second part of this exercise. The order of steps on the worksheet is important to follow because it allows the student to create the legend prior to getting involved in the task of drawing. You, as the teacher, can walk through each step one at a time, if needed, or have the students follow the instructions independently. (10 minutes)*



9. “Sketch” - the final task of this worksheet asks for the student to use their new legend as a guide to sketching out their mapped data in a new way. Students are also asked to note important features. *Students may begin by tracing the outline of the countries and, although it is not necessary and sometimes time-consuming, it is a way that they can begin to process the map spatially. For that reason, the timing of this component is variable and left up to the teacher. Students should have a minimum of 20 minutes to respond or the teacher may choose to break here and allow the students to complete their mapped “work of art” at home overnight and wrap up the next day with Part 2. (20 minutes – 2 hours)*



Part 2 – Analyze & Discuss

1. Looking at the maps they have sketched, ask students to write a one or two sentence summary of what their sketched data represents and then complete **Data Sketches Student Worksheet 2**.
2. Have the students share their answers with their group. (5 min.)
3. Group work Round 1 - Patterns, Correlations, Hypotheses: The group works together to layer two maps at a time and look carefully at the paired maps, noting any patterns and correlations they can find and hypothesizing about what the correlations mean and giving each other feedback.
4. Have students report out as a group to the rest of the class about possible patterns, correlations, hypotheses. (10-20 minutes)
 - a. Why did you choose that design tool?
 - b. Was there anything interesting you discovered when you mapped the data?
 - c. What correlations were you able to find when you layered your maps?
 - d. What do these maps tell us about _____ (topic)?

Wrap Up/Synthesis

1. Group work Round 2 - Evaluating Design Choices. Students discuss the design tools they used and evaluate how well those choices worked in terms of helping their analysis of the data.

Suggested sentence starters:

- *One design tool we used was... It helped us notice...*
- *When we used.... as a design tool, it made it more difficult to notice...*
- *Using as a design tool was interesting because...*
- *If we could do it again, we would do... differently. This is because...*

Have students use a dry erase board to write down their ideas for evaluating their design choices. (10 minutes)

2. Have students report out as a group to the rest of the class about their design choices. (5 minutes)

STEP 4 – Guided Discussion

1. Revisit the questions generated (parking lot/sticky notes) in Step 1.
2. Review if the answers were found during the rest of the activities or if more sleuthing and research needs to be done. This can also be a great jumping off point for other related lessons and activities related to your content.
3. Discuss with the class the following questions:
 - a. What questions did we answer?
 - b. What questions remain?
 - c. How can we find the answers to the remaining questions?
 - d. What skills/tools have we learned that can help us answer them?
 - e. What research can we do? What additional data do we need?

Assessment (Optional)

I assigned the Data Visualization Choices worksheet as homework. In hindsight, if I had more time, I would have reviewed the worksheet with my students as a class. I did not use any formal assessment tools. However, if I were to do it again, I might have the students do a personal assessment of their own participation.