Teacher Guide

Lesson 4: No Two Storms Are the Same

SKILLS:

Lesson question: Which aspects of hurricanes and tropical storms are most hazardous?

Learning objectives:

- Students analyze and interpret data from hurricanes that have impacted their area to understand that each storm has unique characteristics.
- Students identify storm characteristics that have the greatest effect on their community using geoscience data about the storms and data from storm stories.

Timing: Two class periods

Materials:

- Classroom computer, projector, and Internet access
- Lesson 4 slides: Hurricane Characteristics (download from scied.ucar.edu/HurricaneResilience)
- Student page: *Which aspects of hurricanes and tropical storms are most hazardous? (page 39)*
- One set of Storm Data Cards for wind, rain, and water level (download from scied.ucar.edu/HurricaneResilience).
- Table tents with the names of each hurricane or tropical storm in the data
- Chart paper
- Markers
- Timer
- Stray Prompts for Argumentation Session (page 40)
- List of respectful argumentation norms (page 41)
- Student notebooks

Preparation:

- Review the slides.
- Print copies of the student page, one for each student.
- Storm Data Cards are available for ten locations along the U.S. Gulf Coast and East Coast. Locate the collection of Storm Data Cards for storms that occurred in or near your region using the Hurricane Resilience website (scied.ucar.edu/HurricaneResilience). Print the data cards and cut them apart. Familiarize yourself with the data cards to be able to support student learning.

Directions

Day 1

Introduce the lesson.

- Reminds students that, as they learned in Lesson 3, multiple hurricanes and tropical storms have affected their region. Those storms are not all the same, so in this activity, students are going to explore what makes some hurricanes more hazardous than others by analyzing data about a variety of storms.

Orient students to the data.

- Hand out the student page: "*Which aspects of hurricanes and tropical storms are most hazardous?*"
- Introduce the storms. These storms represent a wide variety of tropical cyclones that have affected the region. Some are small tropical storms, and others are Category 3 or 4.

- Introduce the data types (the column headings in the table) and define each type of data using the information in Lesson 2's Slides. (Note that information about the data types categories are on the student page.)
  - **Slide 2:** describes forward speed and footprint
  - **Slide 3:** describes max wind speed and local winds
  - **Slide 4:** describes max rain and local rain
  - **Slide 5:** describes water level
- Model the process that students will use to collect information about each storm using data from Hurricane Issac. Start by writing the storm name and year in a row on their student sheet.
  - Show students the Hurricane Issac wind map (**Slide 6**).
    - The max wind is noted as 81 mph. According to the category scale on the student page, this is in the medium category. Instruct students to add "medium" into their table under max wind.
    - Forward speed is listed as 6 mph. This is in the slow category. Instruct students to add "slow" into their table under forward speed.
    - The footprint is listed as 418 miles, which is in the large category. Instruct students to add "large" into their table under footprint.
    - Local winds require looking at the colors indicating wind speed for a particular area (in this case, Terrebonne Parish, LA). Using the key, students should notice that most winds are in the 40-50 mph color, which would put the local winds in the medium category.
  - Show students the Hurricane Isaac rain map (**Slide 7**).
    - The max rain is listed as 27 inches. This is in the high category. Instruct students to add "high" into their table under max rain.
    - Looking at the map, and its key, students can identify the amount of local rain (i.e., the rain in Terrebonne Parish, LA). Students should notice that there are no areas that got over 10" of rain, which means it's not in the "high" category. Medium (areas with 5-10 inches of rain), is the correct category. Have students note this in their table under local rain.
- Show students the Hurricane Isaac water level graph (**Slide 8**)
    - This graph shows the water level measurements from a number of gauges in the area during Hurricane Isaac. The dark blue line indicates water level measurements in Houma, LA. Comparing the measured water levels with the light blue median levels (which is the average water level over many years for each day), students can figure out that the water level was higher than the median during the storm.

Students collect and categorize tropical cyclone data.

- Make a station for each storm in the classroom that includes the wind, rain, and water level data cards. (Note that water level data is not available for all storms.)
- Instruct students to fill in the parts of the table that correspond with the data for each storm using the same process that the class used for Hurricane Issac.

Students use the data to compare and contrast tropical cyclones.

- Show the Saffir Simpson scale (Slide 9). Explain that hurricane categories are based on max wind speed only. However, students have collected data about a number of other factors that can cause them to be hazardous.
- Have students refer to their data tables to compare two storms that have the same category.
  - Ask how they were similar. *(Their winds were similar.)*
  - Ask how they were different. (Have students compare other hurricane characteristics by asking: Are the storms moving at the same speed? Do they have the same rainfall? Are they the same size?)

- Have students refer to their tables to compare two storms that have very different characteristics.
  - Have students compare the two storms with a partner, looking at the data they collected in their student page.
  - Bring the class back together and ask what characteristics made each storm hazardous. *(Answers will vary depending on the storms, but should be consistent with the data students collected in their data tables.)*

Day 2

Claim-Evidence-Reasoning (CER): Which storm characteristic is most dangerous?

- Write the guiding question on the board: Which storm characteristic is most dangerous?
- Tell students that they will work in groups to construct an argument to answer this question. Then they will share their argument with the class and revise based on the class feedback and questions.
- Give each group a piece of chart paper and markers to record their argument using this basic format:

The Guiding Question:	
Our Claim:	
Our Evidence:	Our Reasoning:

- Familiarize students with the expectations for writing a CER argument:
  - ***Guiding Question:*** Which storm characteristic is the most dangerous?
  - ***Claim:*** an answer to the question. For example, "Our claim is … because …" It should be written as a sentence.
  - ***Evidence:*** data to support the claim. Students should cite evidence from the storm characteristics data they explored and also include at least one piece of evidence from the Storm Stories data supporting their claim. This could be a bulleted list or written in sentences.
  - ***Reasoning:*** the connection between the claim and the evidence. This is an explanation of why the evidence supports their claim. Students can relate their claim to vulnerability and the impact of hurricanes on their community. This is often written in sentences.
- Have each group construct their CER argument and write it on their chart paper.
  - Emphasize that this is complex and there is no one right answer. The task is to construct an argument that makes the most sense to the group based on the evidence available.
  - *(Note: Diligent students may want to dig deeper to come up with additional evidence. To help keep this exercise brief, have students only use evidence from the hurricane data that they analyzed and the storm stories they remember.)*

Mini-Argumentation Session: Sharing Our Thinking

- Have students post their CER argument chart paper posters around the room.
- Explain the purpose of an argumentation session.
  - Stress to students that the goal of argumentation is to learn from each other and bring back information that can be used to strengthen their own argument. It is NOT about proving someone right or wrong.

  - In this case, the word "argument" means a reason and evidence that supports a claim. An argument is communicated to help others understand. (It's not a fight between people who disagree, which is a definition that might be more familiar to students!)
  - Respectful discussion protocols should be adhered to. Disagreeing with ideas and respectful argumentation is encouraged; disagreeing with people's opinions and name calling is not allowed. See the list of *respectful argumentation norms* as a resource.
- Describe the argumentation format. (which is sometimes called "Stay-Stray").
  - Each group will choose one person to stay at their poster and explain it to their classmates in 1-2 minutes, and then answer questions in 2-3 minutes.
  - The rest of the group members will visit other posters to hear from different presenters and ask questions. Group members should split up and go to as many other groups as possible.
  - You will indicate that it's time to switch every five minutes. The presenters stay put, and the other students move to another poster, ideally one that their other group members have not yet visited.
  - Repeat rounds as time allows. Two to three rounds are ideal for allowing students to receive and give feedback.
  - You may want to have students take notes and refer to the list of question prompts during the Q&A portion.
- After the argumentation rounds, students should return to their original groups to debrief and discuss what they learned from their classmates. Provide the following things to consider on the board to help guide group discussions:
  - If other groups made the same claim as they did, what evidence did they use to support their claim?
  - Which arguments did they feel were stronger than others? What made one argument stronger than another?
  - What feedback did your group receive about your own argument? Were there areas that could be clarified or expanded? Are there new ideas that could be added to strengthen your argument?
- In their groups, students should suggest revisions to their argument to strengthen and clarify. They should discuss and reach consensus, if possible, about their final argument. The final version should be written and turned in.
  - You may wish for students to work individually to revise and turn in their own final argument. (This could be completed as out of classwork.) This would provide an individual grade and would document how each student chose to make revisions.

Wrap up the activity.

- Bring the class together and review students' arguments about answers to the question *(Which storm characteristic is most dangerous?)*. Note that there is not one particular characteristic that is a correct answer to this question because a variety of storm characteristics contribute to making a storm dangerous. Thus all arguments can be correct depending on the situation.

Opportunities for Assessment:

- Student work during Day 1 should reflect their ability to analyze and interpret data, including mapped data. Collect the student page and check whether the information that students add to their tables is correct.
- On Day 2, students complete a CER activity, supporting their claim about what aspect of hurricanes is the most dangerous with evidence and reasoning. There is no one correct claim. All characteristics can be hazardous, which should lead students to come up with different claims. Ensure that their evidence is accurate and reasoning is sound.
- During the argumentation rounds on Day 2, visit each group and note whether students are following the respectful argumentation norms and whether the information discussed is helpful for strengthening arguments.
- Consider having the final arguments be written up by each student individually to allow assessment of individual understanding of the claim, evidence, and reasoning.

Name:

Which aspects of hurricanes and tropical storms are most hazardous?

Lesson 4 Student Page

To learn more about hurricanes and tropical storms that affected a region, you will analyze and interpret data about the size, forward speed, winds, rain, and water level during past storms.

For each type of data, assign each storm a category (using the ones on the right) based on the maps, graphs, or measurements. (For example, if a hurricane had a forward speed of 21 mph, it would be in the "fast" category.)

Write the name of the storm and the categories into the table below.

Storm name and year	Data Type: Forward speed	Data Type: Footprint	Data Type: Max wind speed	Data Type: Max rain	Data Type: Max flooding

Categories for each data type:

FORWARD SPEED
Fast = above 15 mph
Medium = 10-15 mph
Slow = less than 10 mph

FOOTPRINT (geographic size)
Large = more than 300 miles across
Medium = 200-300 miles across
Small = less than 200 miles across

MAX WIND SPEED
High = more than 100 mph
Medium = 75-100 mph
Low= less than 75 mph

MAX RAIN
High = More than 20" of rain
Medium = 10-20" of rain
Low= less than 10" of rain

MAX FLOODING (based on water level)
High = more than 6 feet
Medium = 3-6 feet
Low = less than 3 feet

How to estimate footprint:

Use the wind map to estimate a storm's footprint, which reflects the geographic size of the storm.

Put a piece of paper or a ruler perpendicular to the storm track (black line) and measure the maximum distance where winds were at least 40 mph.

Compare the distance you measure to the scale on the map to find the footprint in miles.

Stray Prompts for Argumentation Session

GENERAL QUESTIONS

1. I'm still not quite clear about what you are saying. Can you tell me more about that?
2. Why do you think that?
3. What is your evidence for that idea?
4. Thinking about where you got blocked, how could we help you or your group?
5. Did you consider .....?
6. I agree with your group about ..... but I'm not sure that I agree with .....

EXPERIMENTAL DESIGN QUESTIONS

1. What did your group do to collect that data?
2. Why did you think that way was the best to do it?
3. What did your group do to make sure that your measurements were correct?
4. What did your group do to make sure that your calculations were correct?
5. What did your group do to be systematic? (try one thing at a time)

CLAIM QUESTIONS

1. How do you know that your claim is valid (right?)
2. What other claims did your group discuss before you decided on that one?
3. Why did your group abandon the other claims?

EVIDENCE QUESTIONS

1. Can you explain how you analyzed the data to find patterns and trends?
2. Why did your group use that approach to analyze the data?
3. Was there any evidence or data that did not fit your claim?

REASONING QUESTIONS

1. What other interpretations of the data did your group consider?
2. "But how does that evidence support that claim?" (Reasoning)
3. What else could you do to be more certain?

JUSTIFICATION QUESTIONS

1. How does your claim fit with scientific theories or laws that you have studied?
2. What could you do next to be more certain that your claim is completely correct?
3. How certain are you that your group's claim is accurate? What are you still uncertain about?

Respectful Argumentation

1. Respect for the other person is more important than your ideas.

2. Don't interrupt.

3. Don't dominate. Allow others to ask questions (even invite them).

4. Challenge ideas, not people or groups.

5. Remember that the goal is "improving your argument," not "winning."

6. Remember that your goal is to learn from the other person to help them and your group.

7. Evaluate the evidence, not the person.

8. Ask "open-ended" (not yes/no) questions that require the person to explain, and not defend.

Adapted from resources developed at the Denver Museum of Nature and Science.