Tsunami Storyboard

Lesson Overview

In this lesson, students' prior knowledge of ocean currents and waves will be pre-assessed as they create a storyboard of a tsunami.

SC Standards Addressed

6.S.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

6.S.1A.4 Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.

Note: This lesson was created for and implemented with a 6th Grade Earth Science class at Cathedral Academy, a private Christian school in Charleston SC, that does not follow the SC Academic Standards. This lesson aligns well for the following 5th grade standard and with some additional rigor could also address the following 8th grade standard:

- **5.E.3B.1** Analyze and interpret data to describe and predict how natural processes (such as weathering, erosion, deposition, earthquakes, tsunamis, hurricanes, or storms) affect Earth's surface.
- **8.E.5B. Conceptual Understanding:** Natural processes can cause sudden or gradual changes to Earth's systems. Some may adversely affect humans such as volcanic eruptions or earthquakes. Mapping the history of natural hazards in a region, combined with an understanding of related geological forces can help forecast the locations and likelihoods of future events.

Disciplinary Literacy Strategies

Strategy Used: Jigsaw, Most Important Point, Give Me Five

Computational Thinking

Tools:
Storyboards

Cornerstone(s) Addressed:

- Decomposition: Students must breakdown the cause of a Tsunami into 6 steps (boxes for their storyboard).
- Pattern Recognition: Students must find the pattern in what they read and learn about Tsunamis, to determine what causes them.
- Abstraction: Students must choose what vocabulary is not relevant to their story.
- Algorithmic Thinking: Students must determine in what order they will tell their story.

Lesson Plan

Time required: Two 55-minute periods

Focus Question(s):

- What natural phenomenon precede (cause) Tsunamis?
- How might we protect ourselves from Tsunamis?

Disciplinary Vocabulary: Rip Current, atoll, lagoon, tsunami, upwelling, counter current, surface current, subsurface current, earthquake, thermocline, oceanographer, waves.

Materials needed:

- Colored Pencils/ Pens / Crayons
- Chart Paper & Drawing paper

- "Wave of the Future" article parts (4) – for the Jigsaw Reading (*attached*)
- Tsunami Video (*"The Impossible" - link provided*)

Engage

- Show a video clip of a Tsunami – The movie preview of "The Impossible" is a good example.
- Ask table groups to discuss one of the following questions:
  - What kind of warning did they have?
  - What did you notice about the ocean before the tsunami?
  - What actions seemed to keep people safe?
- Use "Give me Five" to get a few answers (get at least one response for each question)

Explore

- Number students 1-4 (*each group of four is a 'home' group) (each number is an 'expert' group – there are 4 expert groups – the number of home groups will depend upon the number of students in the class*)
- Distribute the parts of the "Wave of the Future" article (*attached*) (*each expert group gets one part of the article: 1's get part 1, 2's get part 2, etc.).*
- Students read and identify the "Most Important Points" in their part of the article
- In expert groups (1-4) students share their "Most Important Points" and decide what should be shared with their 'home' group.

Explain

- Students return to their home groups and share the most important parts from their expert group.
- Provide students the opportunity to review the word wall (vocabulary) for ocean waves and currents (*see disciplinary vocabulary above*).

Elaborate

- Home groups work together to determine vocabulary they need to tell the story of a Tsunami.
- Home groups work together to create their storyboards.

Evaluate

- Students post their storyboards and the class completes a gallery walk – making notes of things they might want to add to their own storyboards.
- Students use the rubric (*attached*) to evaluate other groups' storyboards.

Assessment Notes: Students will be formatively assessed on a) their ability to work together and, b) a compilation of their group's rubric scores.

Resources:

The Impossible Preview: https://www.youtube.com/watch?v=uCqUoPaaH0I
Resources for Tsunamis:

- https://ocean.si.edu/planet-ocean/tides-currents/currents-waves-and-tides-ocean-motion
- https://www.noaa.gov/education/resource-collections/ocean-coasts-education-resources/ocean-currents
- https://www.weather.gov/phi/tsunami

Resources for Ocean:

- https://oceanservice.noaa.gov/education/lessons/welcome.html#earth
- https://www.educationworld.com/a_lesson/lesson193.shtml
- https://www.nationalgeographic.org/education/programs/oceans-education/

Teacher Biographical Information

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Tsunami Storyboard Rubric

Category/Score	4	3	2	1
Use of Vocabulary: Tsunami Description	The Tsunami's origin and progress are accurately described.	The Tsunami's origin and progress are described with minor inaccuracies.	The Tsunami's origin and progress are inaccurately described.	The Tsunami's origin and progress are not described.
# of Terms	Used all the terms	Used 90% of the terms	Used 80% of the terms	Used less than 80% of the terms
Accuracy	Terms used with 100% accuracy	Terms used with 90% accuracy	Terms used are 80% accurate	Terms used are less than 80% accurate
Number of Story Blocks	All 6 blocks are used to describe the process	5 Blocks-are used to describe the process	4 blocks are used to describe the process	Less than 4 blocks are used to describe the process
Storyboard has a Title	Yes			No
Names, Date and Class labeled	Yes			No
Story Components	It has an exceptional setting, plot, character and theme	It has a reasonable setting, plot, characters and theme	One or more of the components is inconsistent	One or more of the components are missing
Includes	Information about, 1) warning signs, 2) warning systems, 3) past events, and 4) possible costs	Information about three of the four pieces of listed information	Information about two of the four pieces of listed information	Less than 2 of the pieces of listed information
Graphics/ Drawings	Accurately depict the scene and vocabulary listed in all 6 blocks	Accurately depict the scene and most of the vocabulary in all 6 blocks	Inaccurately depict vocabulary but are relevant to Tsunami and the story	Are not relevant

Wave of the Future

by Peter Tyson

Part 1: What will it take to be ready for the next major tsunami?

If only people along Indian Ocean coasts had known to flee when the sea retreated on December 26, 2004, thousands of lives might have been saved. Here, fishermen in Sri Lanka collect washed-up fish five days after the tsunami.

Enlarge this image

One of the most wrenching signs of the lack of readiness for the tsunami in the Indian Ocean, was the enthusiasm of children, as reported by survivors, who rushed excitedly down to the beach during the initial drawdown of water to gather fish left suddenly stranded. Those children, their parents, and most everyone else in the ill-fated coastal communities struck that day, had no idea what the sea's strange retreat meant—namely, that it would be returning within minutes with unthinkable fury, bulldozing everything in its path.

No one knew- because nothing like that had happened in living memory. The last widely devastating tsunami in the Indian Ocean, was that spawned by the eruption of Krakatoa in 1883, which killed 36,000 people. Disaster officials in the region understandably have focused on cyclones, floods, and other natural calamities that strike the region every year.

Now, in the wake of one of the worst natural disasters in recorded history, their focus has broadened. Within days of the catastrophe, with the adage "better late than never" sitting heavily on everyone's minds, commentators worldwide were calling for a tsunami warning system in the Indian Ocean akin to a successful one now operating in the Pacific. If such a system had been up and running in the Indian Ocean, experts agree that many of the thousands of lives lost in places relatively distant from the quake's epicenter, such as Thailand, Sri Lanka, and India, might have been saved.

But setting up a truly effective warning system, one that can alert coastlines even as close to a tsunami's birthplace as northwest Sumatra was last December, is a daunting task. In talking to a host of experts on tsunami detection and hazard mitigation, it's clear that numerous challenges exist to ensuring that disaster officials are well-prepared for the next big tsunami—which, incidentally, could arise at any time off the coast of the U.S. as close as it was off Sumatra.

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Part 2: Towards a warning bell

Before installing a warning system, experts need to identify and map areas of risk. Much of this preliminary work has been done in the Indian Ocean; some needs more effort. The work includes identifying tectonic faults, mapping the seafloor, studying the effects of past tsunamis, and making computer models showing how future tsunamis might behave.

The world's first tsunami warning system was created two years after enormous waves triggered by a 1946 earthquake in Alaska crashed ashore thousands of miles away in Hawaii (above).

Enlarge this image

"Computer models are the brain of any warning system," says Tad Murty, a tsunami expert at the University of Manitoba. "We will run a series of scenarios, … combinations of anything that can happen, so that when an earthquake occurs, the computer will match the closest scenario and then use it to help with warning."

Murty estimates an Indian Ocean warning system will cost between $250 and $400 million.

The Pacific system was established two years after a 1946 quake off Alaska spawned a tsunami that killed over 100 people and caused massive destruction around the Pacific. Initially the system was based on seismic data plus inputs from a series of tide gauges that sent information about water levels around the ocean to warning centers in Hawaii, Japan, and elsewhere in the Pacific. Experts used the system to accurately "call" every major tsunami in the years since, but wishing to err on the side of conservatism, they also had a false-alarm rate until relatively recently of 75 percent.

Then, in 2002, new sensors went into place. Six monitoring devices anchored to the seafloor far out in the Pacific measure changes in water pressure above. When such changes indicate a tsunami passing overhead, a sensor sends a signal with data to a buoy directly above, which forwards the message via satellite to the Pacific Tsunami Warning Center (PTWC) in Hawaii. Specialists then analyze the data, decide if a potentially dangerous tsunami is under way, and take appropriate action.

The new system has already proved its value. In 2003, experts were able to call off a warning after analysts determined that the tsunami generated by a big quake off Alaska was not hazardous. Within weeks of the Indian Ocean tsunami, President Bush ordered that 32 additional such buoys be added to the Pacific as well as to the Atlantic and Caribbean (neither of which currently has a tsunami warning system, even though both have on occasion spawned deadly tsunamis)

Wave of the Future
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Part 3: Fine Tuning

A sign along Highway 100 in Fort Canby State Park, Washington

Enlarge this image

The Pacific warning system is not perfect, however. For one thing, the seismic data currently quickly tells about a quake's epicenter, but not about the alignment of the rupture. If experts had known immediately that the Sumatran rupture had been along the north-south portion of the fault, they would have known that any resulting tsunami would have traveled largely east-west and could have predicted what targets lay in its path. "Right now, there's no quick way to know which way that rupture goes," says Chip McCreery, director of the PTWC. "We need to figure that out."

It took about two hours, based on calculations made at Harvard's Centroid-Moment Tensor Project, for PTWC officials to learn that it was a 9.0. (Some seismologists now believe the quake might have been a 9.3.) Every undersea quake of that magnitude has triggered a lethal tsunami, says Tom Heaton, a seismologist at the California Institute of Technology.

Heaton stresses that it was not the fault of the PTWC but rather what he believes is a certain lack of communication between the seismic and tsunami communities. But fixing this specific problem is straightforward, he believes: the capability exists for centers such as the PTWC to detect the size of earthquakes anywhere in the world within minutes after the event, at a cost of perhaps $100,000 and several months of work to upgrade software, he says.

Earthquakes smaller than 9.0 can also launch tsunamis. All tsunamis are different and determining their level of threat can be tricky. On the one hand, experts can't afford to be wrong—to fail to warn about a tsunami that ends up taking lives. On the other hand, evacuations are costly. In Hawaii, the price tag to stage an evacuation is over $50 million, says George Curtis, a tsunami expert at the University of Hawaii at Hilo. "You have a tremendous loss of business. You have a great expense of overtime for police, firemen, road crews putting up roadblocks. It's a major disruption." And if you have too many false alarms, a cry-wolf reaction occurs, and citizens grow complacent.

Even the finest warning system, with the best technology and personnel, will be useless without the means to communicate warnings to relevant authorities. Sadly, the 2004 tsunami showed up this lack all too well in the Indian Ocean. In Thailand, for example, seismologists knew early on how big the quake was and that it probably spawned a big tsunami. "But for an hour they didn't know what to do about it," says Curtis. "They didn't know who to call."

Wave of the Future
by Peter Tyson

Part 4: Learn and Live

At a tsunami relief center in Cuddalore on the Indian coast, a father and his son eat breakfast on December 31, 2004.

Enlarge this image

The final piece of the puzzle is education. In potentially vulnerable parts of the Pacific region, from Japan to Hawaii to Alaska, vigorous public education programs have been in place for some time. One such hot zone runs for nearly 700 miles along the Pacific Northwest coastline stretching from Washington, through Oregon, and into northern California. Any tsunami could hit nearby shores within 20 to 40 minutes.

"The educational program they have in place there is that you should have a backpack filled with all the stuff you need to be self-sufficient for a couple of days," says Eddie Bernard, director of the Seattle-based Pacific Marine Environmental Laboratory, which developed the buoy-based warning system and is a leading center of tsunami research. "Once you feel the earthquake, you grab that backpack on your way out of your house." Both authorities and residents have been indoctrinated with where to go and what to do.

Time can be the enemy of effective education, however. "Humans are amazingly adaptive animals, so those impacted will remember this horrific tsunami," says Bernard. "It's our responsibility to devise effective educational programs to ensure that the next generation does not forget." McCreery, for one, says it's vital to get tsunami hazards into school curricula. In devastated parts of the Indian Ocean, local authorities could also erect memorials to victims that double as warning signs. "The memorial could explain what the hazard is, that it's going to happen again, and what to do," he says.

For residents of coasts extremely close to subduction zones, and really for anyone who ever visits a beach on vacation, it's essential to know nature's three tsunami warning signs, Bernard says. "If you feel an earthquake, if you see the water retreating, or if you hear a loud roar from the ocean, those are three natural indicators that a tsunami could be present. In any of those cases, head inland fast. Every step you go inland, even if it's not up, is a step toward more safety."

