

Quakeland

Earthquakes in Oklahoma

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Grade Level	11th – 12th Grade	**Time Frame**	125 minutes
Subject	Science	**Duration**	3-4 class periods
Course	Earth Science, Environmental Science		

Essential Question

How are humans impacting Earth's systems? What effects are these impacts having on the citizens of Oklahoma?

Summary

Students will look at the increase in seismic activity in Oklahoma and around the United States in recent years. Some say the earthquakes are a direct result of an oil and gas process called hydraulic fracturing, while others disagree. Students will investigate this question for themselves and formulate their own hypotheses.

Snapshot

Engage

Students seek to answer the essential questions by tapping into their previous knowledge to compile a word cloud.

Explore

Students explore a variety of sources in a resource collection board and seek to answer several guiding questions as a group.

Explain

Students watch an ICAP video featuring Jake Walter, a geologist working with the Oklahoma Geological Survey.

Extend

Students Jigsaw a set of short articles to learn about Fracking, the Economic Impact of Fracking, the Environmental Impact of Fracking, and why the number of earthquakes seems to be decreasing in Oklahoma.

Evaluate

Students complete an Exit Ticket to synthesize what they have learned about how scientists approach a problem.

Standards

Next Generation Science Standards (Grades 9, 10, 11, 12)

HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Oklahoma Academic Standards (Environmental Science)

EN.ESS3.1 : Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate effect human activity.
EN.ESS3.1.1: Resource availability has guided the development of human society.
EN.ESS3.1.2: Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations.

Attachments

- Exit Ticket—Quakeland.pdf
- Lesson Slides—Quakeland.pptx
- Student Reading 1—Quakeland.docx
- Student Reading 1—Quakeland.pdf
- Student Reading 2—Quakeland.docx
- Student Reading 2—Quakeland.pdf
- Student Reading 3—Quakeland.docx
- Student Reading 3—Quakeland.pdf
- Student Reading 4—Quakeland.docx
- Student Reading 4—Quakeland.pdf

Materials

- Lesson Slides (attached)
- Student Readings (attached; enough copies so that each student receives one of the four readings)
- Exit Ticket handout (attached; one per pair of students)
- Highlighters (optional)
- Pens or pencils
- Student devices with Internet access

10 minutes

Engage

Teacher's Note: Sensitive Topic

When presenting this lesson, keep in mind its potentially sensitive nature. Some students' families might have been affected by earthquakes. Other students might have family members who work in the oil and gas industry. For those reasons, it is important to approach the topic with sensitivity and understanding.

Teacher's Note: Lesson Preparation

This lesson uses a pre-made Mentimeter presentation that you will need to copy to your own account before using. Follow these steps to copy the Mentimeter presentation to your own Mentimeter account and update the link:

1. Open the presentation by visiting this link.
2. Select "Copy to your Account."
3. Once in your account, choose "Share" to get a new link for your students.
4. Paste your new link into slide 5 of the **Lesson Slides**.

Begin the lesson by sharing **slides 3-4**, presenting the lesson objectives and essential questions to the extent you feel necessary**.**

Encourage students to tap into previous knowledge and their own experiences to guide their upcoming learning. Move to **slide 5** and introduce the Collaborative Word Cloud strategy. Have students use the Mentimeter link to respond to the following questions:

- How do earthquakes impact the people in Oklahoma?
- What do you think is the cause of Oklahoma's earthquakes?

Share the word clouds with the class and take some time to discuss students' responses.

20 minutes

Explore

Move to **slide 6** and share the HIVE link. The HIVE features maps, graphs, videos, and readings. Instruct students to consider the following questions as they explore the resources:

- What do you notice?
- What is happening?
- Are there any trends? If so, are they positive? Negative?
- What is contributing to the earthquakes?
- Which year was there a spike/sharp increase?
- What do you believe is the cause of the earthquakes?
- What do you think will happen if there is an increase in fracking?
- What is your prediction for five years from now? Why?

Once students have had sufficient time to explore on their own, bring them back to a whole-group discussion and go through the questions together. Optionally, bring up the word cloud from the previous activity and ask students if there are any words or phrases they would like to add after having completed their exploration.

25 minutes

Explain

Display **slide 7** and explain to students that the work they have done with exploring the data and trying to determine a root cause of earthquakes is similar to what geologists do in the field. Play the ICAP - Quakeland video interview with Jake Walter, a geologist working with the Oklahoma Geological Survey. In the video, Walter shares insight into his career and discusses earthquake activity in the state of Oklahoma.

Embedded video

https://youtube.com/watch?v=0rq0T9DDueM

After watching the video, take some time to debrief with students through a class discussion about the main points that were addressed. Consider using the POMS: Point of Most Significance strategy to help frame the discussion.

60 minutes

Extend

Display **slide 8** and introduce the Jigsaw strategy. Divide students into four groups and pass out copies of one of the attached readings to each group:

- **Student Reading 1**: *Fracking in North Dakota (Fracking Background)*
- **Student Reading 2**: *Fracking in North Dakota (Economic Impact)*
- **Environmental Impact**
- **Student Reading 4**: *Earthquakes Continue To Decrease in Oklahoma for the Third Straight Year*

(Each student in the group should have a copy of the same article.)

Instruct students to read the articles individually and highlight any information that stands out to them as important that they will want to share with the group. After they have had ample time to read and gather their thoughts, move to **slide 9** and have group members work together to discuss what they learned and synthesize what they want to share with the rest of the class.

Divide students into new groups of four so that each person in the new group has read a different article. Move to **slide 10** and students take turns sharing with their new groups what they have learned from their reading.

25 minutes

Evaluate

Display **slide 11** and pass out the attached Exit Ticket. Have students reflect on their learning and respond to the three questions.

1. What have you learned about how scientists approach a problem?
2. How do earthquakes impact people in Oklahoma?
3. What do you think is the cause of Oklahoma's earthquakes?

Collect the Exit Tickets to assess students' learning at the end of the lesson.

Resources

- 60 Minutes. (May 2016). *'60 Minutes' investigates rise in Oklahoma earthquakes* [video]. CBS News. https://www.cbsnews.com/video/60-minutes-investigates-rise-in-oklahoma-earthquakes/
- Geology.com. Map of Oklahoma cities and roads. https://geology.com/cities-map/oklahoma.shtml
- K20 Center. (n.d.). Collaborative word clouds. Strategies. https://learn.k20center.ou.edu/strategy/103
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- KFOR Oklahoma's News 4. (2019, July 29). *Swarm of More Than Two Dozen Earthquakes Halts Oil Operation in Oklahoma*. https://youtu.be/WH5fBl_DQxc?si=vdMvapWx9kIPgyzq
- SeismicSoundLab. (2017). Oklahoma injection-induced seismicity. [video]. Vimeo. https://vimeo.com/186029718?embedded=true&source=video_title&owner=48249274
- Topographic map of Oklahoma. (2015, March 9). https://commons.wikimedia.org/wiki/File:Oklahoma_topographic_map-en.svg
- U.S. Energy Information Administration. (n.d.). Oklahoma field production of crude oil. Oklahoma field production of Crude Oil (thousand barrels). https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrfpok1&f=m
- U.S. Environmental Protection Agency. (n.d.). *Final Report: Oil and Gas Extraction Wastewater Management*. https://www.epa.gov/eg/final-report-oil-and-gas-extraction-wastewater-management
- U.S. Geological Survey. (n.d.). *Oklahoma has had a surge of earthquakes since 2009. Are they due to fracking?* https://www.usgs.gov/faqs/oklahoma-has-had-surge-earthquakes-2009-are-they-due-fracking
- U.S. Geological Survey. (2019). *Preliminary Fault Map of Oklahoma*. Files. https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/atoms/files/OklahomaPreliminaryFaultM
- UTD GEOSCIENCE STUDIO. (2020, June 2). *Induced Seismicity - The Oklahoma Story*. HRzp8nKnDqc?si=IhziZ1VkWfagfLnB
- Walter, J. I., P. Ogwari, A. Thiel, F. Ferrer, I. Woelfel, J. C. Chang, A. P. Darold, and A. A. Holland (2020), The Oklahoma Geological Survey Statewide Seismic Network, Seismol. Res. Lett., 91 (2A): 611–621, doi:10.1785/0220190211. https://ogsweb.ou.edu/eq_catalog/
- Z22. (2014). Seismogram at Weston Observatory. Wikimedia Commons. Retrieved March 2, 2022, from https://commons.wikimedia.org/wiki/File:Seismogram_at_Weston_Observatory.JPG.