



The Science and Civics of the Flint Water Crisis (High School Version)

OVERVIEW

ESSENTIAL QUESTION

What is the Flint water crisis, and why did it occur?

OVERVIEW

Note: This lesson contains strong language. Teacher discretion advised.

On April 25th, 2014, officials in Flint, Michigan held aloft glasses filled with water from the Flint River, in a toast to the city's new public works project. For nearly 50 years, the city purchased treated water from Detroit, but in 2013 the City Council approved the construction of a pipeline that would bring water directly from Lake Huron into the city. The Flint River would provide the city with water until the pipeline was built.



Photo: U.S. Army Corps of Engineers

Switching the water supply was considered above all else a necessary cost-cutting measure for the city. The birthplace of General Motors and a booming center of the automobile industry for much of the 20th century, Flint's financial stability began to falter in the 1980s, as General Motors began outsourcing, offshoring, and automating autoworker jobs. In 2002, Michigan Governor John Engler declared a financial emergency in Flint, and installed what would be a series of unelected Emergency Managers who were given authority to oversee the city's finances. From 2002 to 2018, these managers began laying off city workers, cutting benefits, eliminating social programs, and raising water bills in an attempt to balance the city's budget. Fatefully, the city managers also decided—without approval from the city council—to bring an end to the city's reliance on Detroit water before the completion of the Lake Huron pipeline by drawing water from the Flint River.

Almost immediately after the switch, residents began to grow worried about the smell, taste, and appearance of the water. Some started reporting sudden medical concerns such as rashes and hair loss. By the beginning of 2015, the Flint City Council voted to move the city back to water from Detroit, a decision that was denied by Emergency Manager Gerald Ambrose, who argued the switch back would be too costly. Upon retiring from the position, Ambrose then signed orders prohibiting other Flint officials from revising any of his past actions for at least a year.

In the meantime, scientists and doctors grew concerned with the safety of Flint's drinking water. Local and national researchers found dangerous levels of lead in the drinking water, among

other pollutants, and doctors in the area began to warn parents against using tap water. In response, state regulators continued to claim the water was safe to drink, even after it was revealed that Flint's Emergency Managers did not add corrosion control to the Flint River water treatment process as a cost-cutting measure—a vital step to insuring lead from plumbing does not filter into tap water. The Michigan Department of Environmental Quality even tampered with research data and dismissed the results of other tests to maintain this stance that Flint's drinking water was safe.

Finally, in October 2015, a year and a half after residents were first exposed to toxic drinking water, Michigan Governor Rick Snyder ordered the city's water supply switched back to Detroit. Three months later, Snyder declared a state of emergency in the city, and began distributing bottled water and filters to residents.

As of 2019, no governmental officials have been convicted of any crimes related to the Flint water crisis. And while the water in Flint has been tested safe to drink, residents are living with the lifelong effects of lead poisoning, and a skepticism towards authorities brought about after being told for nearly a year that water with high amounts of lead was safe to drink.

In this lesson, students listen to Flint-based rapper Jon Connor's song "Fresh Water for Flint" to better understand the sense of frustration and injustice people living in the city felt during the water crisis. Students then experiment with creating their own water filtration system to better understand the scientific and engineering principles behind water treatment. Lastly, they consider the biological effects of lead poisoning and determine specific, political, economic, and scientific causes behind the Flint water crisis.

MATERIALS REQUIRED:

- 2-liter soda bottles, cut in half horizontally
- Water "Pollutants," which could include dirt or soil, coffee grounds, dish washing liquid, baking soda, vinegar, food coloring, vegetable oil
- Rubber bands
- Cheesecloth
- Measuring cups
- Spoons
- Filter material: cotton balls, small pebbles, sand, coffee filter, active charcoal
- A water quality monitoring kit
- Beakers

OBJECTIVES

Upon completion of this lesson, students will:

1. KNOW (KNOWLEDGE):

- The process of water treatment
- The biological effects of lead poisoning
- The cause of the Flint water crisis
- The artist Jon Conner and pediatrician/activist Dr. Mona Hanna-Atisha, and their role within the Flint water crisis
- The governmental response to the Flint water crisis

2. MASTERY OBJECTIVE

- Students will be able to identify the causes and effects of the Flint water crisis through hands-on experimentation and the analysis of primary source documents.

ACTIVITIES

PREPARATION

1. Create a large container (around 2 liters) of “dirty water” by mixing clean water with various pollutants such as dirt, liquid detergent, vinegar, and/or food coloring.
2. Cut the 2-liter bottles in half horizontally, and place the top half face-down in the bottom half.

MOTIVATIONAL ACTIVITY

1. Play Jon Connor’s song “Fresh Water for Flint” at <https://youtu.be/EsmoxpWfi80> (*Note: The song contains strong language, teacher discretion advised. The link will open to the official song on YouTube, we suggest loading the video before class to avoid showing advertising during class.*) Ask students:
 - What event is being referred to in the sample at the beginning of the song?
 - Based on any prior knowledge, what do you know about the Flint water crisis?
 - What do you feel is the mood of this song? What emotion do you think Connor is conveying? What aspects of the song lead you to this conclusion? (*Students might consider the prevalent use of powerful drums, the strong lyrics, the angry tone in Connor’s voice, etc.*)
 - Why might Connor be conveying this emotion in the song?
 - Why might Connor feel so strongly about the situation in Flint? (*Connor is from Flint, Michigan.*)

PROCEDURE:

1. Tell students that in this lesson they will be examining the science and politics behind the ongoing Flint water crisis, which relates to the water treatment. Ask students:
 - What is water treatment? (*Water treatment is the process by which water is cleaned and disinfected for healthy consumption.*)
 - Why is water treatment important? What might result from ineffective water treatment?
2. Divide students into groups, and tell them they will be creating and experimenting with their own water treatment systems. Have each student group go to a station. Each station should contain:
 - A 2-liter soda bottle, split in half.
 - Cheesecloth, cut into a 3" square
 - Cups full of various filtering components: small pebbles, large pebbles, sand, coffee filters, activated charcoal
 - A rubber band
 - A beaker
 - A water testing kit
3. Decide as a class what they will be testing their water for (*the tests differ depending on which test kit is purchased. For instance, different kits may provide tests for pH level, iron, turbidity, etc.*) Then, as a class, conduct the tests on the dirty water created before class, which could either represent waste water (*any water affected by human use*), or naturally occurring water from rivers, lakes, and reservoirs. Record the results of the tests on the board, for the whole class to see.
4. In their groups, ask students to wrap the cheesecloth around the bottleneck of the 2-liter bottle, and secure it with the rubber band. Have students place the bottleneck face down into the other half of the bottle. Then ask students to experiment with placing different filtering materials in the top of the bottle, running the dirty water through the filter into the beaker, and testing the result with the water treatment tests. (A YouTube video of this process can be found at <https://youtu.be/1vovK75C4hY>.)
5. Give each student group **Handout 1 - Filtering Experiment Observations**, and ask students to record their experiments on the handout. Students should experiment with different filtering materials, tests, and different ways in which the materials are layered.
6. After the experiments, ask student groups to share the results of their water treatment tests. After comparing their results, ask the class:
 - In general, which filter materials changed the results of the water test?
 - Did different filters have different effects on the results?
 - Did different filter combinations have different effects on the results? What combination seemed the most successful?
 - Were there any tests in which filters made no difference?
 - Based on the class's evidence, which filter system is the most efficient at eliminating pollutants in water?

- Based on the results of the experiments, do you think filtering is the only process in water treatment?
7. Show **Image 1, Water Treatment Diagram**. Read aloud as a class each step in the water treatment process. Ask students:
- How many processes in this diagram did the class cover in the experiment?
 - Why are all these steps required to treat water? What do they each accomplish?
 - What might happen if one of these steps is eliminated?
8. Tell students they will now be watching an interview with Dr. Mona Hanna-Attisha, a pediatrician who was the first to discover high levels of lead in Flint’s drinking water. Play **“Dr. Mona Hanna-Attisha on Discovering Lead in Flint”** (<https://www.c-span.org/video/?c4802313/dr-mona-hanna-attisha-discovering-lead-flint>). Ask students:
- According to Hanna-Attisha, what types of products or processes expose people to lead?
 - Why does Hanna-Attisha describe lead exposure as a form of “environmental injustice”? What kinds of people are most affected by lead exposure?
 - Why did Hanna-Attisha “freak out” when discovering there was lead in Flint’s water supply?
9. Pass out **Handout 2 - “Lead Poisoning and Health”** from the World Health Organization. Read the article out loud as a class, and then ask:
- What is lead? Where is it found?
 - How can lead enter into the body?
 - What systems of the body does lead affect?
 - Where is lead stored in the body, and how is it distributed throughout the body?
 - What are some of the symptoms of lead poisoning?
 - What kinds of people are particularly vulnerable to lead poisoning? Why?
10. Play clip, **“Dr. Mona Hanna-Attisha on the Cause of the Flint water crisis.”** Then show **Image 2, Map of Michigan**, and ask students:
- According to Hanna-Attisha, why did the city officials of Flint decide to switch water sources? What new source of water was chosen?
 - Based on the map of Michigan, did the city of Flint lack any nearby sources of fresh water?
 - What caused lead to get into the water? Was lead present in the Flint river, or did get into the water in another way?
11. Show **Image 1, Water Treatment Diagram** once again. Ask students:
- What component of the water treatment process is Hanna-Attisha referring to?
 - What might have caused the city of Flint to not include this component in the treatment of the Flint river water?
12. Pass out **Handout 3 - “Why didn’t Flint treat its water? An answer, at last”** After reading the article, ask students:
- What component of the water treatment process is Hanna-Attisha referring to?

- What might have caused the city of Flint to not include this component in the treatment of the Flint river water?

SUMMARY ACTIVITY

1. Ask students:

- Based on what you discovered in class, why might John Connor have expressed so much anger in the song “Fresh Water for Flint”? As a resident of Flint, what might be the source of his frustration?
- Why did the Flint water crisis occur? Was it a problem that required new scientific research or technological innovation to solve? Or was it something else?

2. Show **Image 3, Water Quality Action Plan**. Ask students to follow the instructions in the image, and share their action plan with the rest of the class.

EXTENSION ACTIVITY

1. **Writing Prompt:** Once Mona Hanna-Attisha’s research revealed high levels of lead in Flint’s water supply, she immediately took her findings public. Her actions went against scientific protocol, which requires research to be peer-reviewed, or verified by other scientists, before being made public. Hanna-Attisha defended her actions by arguing that Flint was undergoing a public health crisis that couldn’t wait for scientific verification. Write a short paper arguing whether Hanna-Attisha made the right decision in this circumstance. In your paper, consider the possible repercussions if Hanna-Attisha’s findings were not accurate.
2. **Writing Prompt:** The Flint water crisis reveals that science and scientific research never exists in a vacuum—it is connected with issues of politics and economics. Given this fact, do you think it is part of a scientist’s responsibility to be politically and socially involved? Or, is a scientist’s primary role to focus on conducting research and advancing technologies, leaving issues of politics and economics to others? Simply put, are activism or advocacy essential parts of being a scientist?
3. Research another instance of environmental racism. Write a summary of the issue and the community it has affected. Include in your summary scientific explanations on why the particular pollutant is harmful, whether it is affecting people today, and its similarity or difference to the Flint water crisis. Possible instances to investigate might include:
 - Superfund Sites in the United States
 - Cancer Alley
 - The Response to Hurricane Katrina
 - Denmark, South Carolina water contamination
 - The Dakota Access Pipeline
 - Air Pollution in South Los Angeles

4. Read the New York Times article “Flint’s Water Crisis Started Five Years Ago. It’s Not Over,” (<https://www.nytimes.com/2019/04/25/us/flint-water-crisis.htm>) and summarize how the Flint water crisis continues to affect people today.
5. Read the article “Children’s Health Research Centers Protect Our Kids. The EPA Just Defunded Them,” (<https://blog.ucsusa.org/kathleen-rest/childrens-health-research-defunded-by-epa>) and answer the following questions:
 - What is the purpose of the Children’s Health Research Center? What kind of research has been funded through this program?
 - According to the author, why must children’s health research be different than adult health research? What evidence does the author provide to support this argument?
 - According to the author, what was the motivation behind cutting funds for this program? Is it related to children’s health, or something else?
 - According to the author, what might the impact be of the decision to defund this program?
 - How is this decision similar to the decisions that led to the Flint water crisis?
 - What is the author advocating at the end of this article?

COMMON CORE STATE STANDARDS

College and Career Readiness Anchor Standards for Reading (K-12)

Reading 1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

Reading 2: Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

Integration of Knowledge and Ideas 7: Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

Range of Reading and Level of Text Complexity 10: Read and comprehend complex literary and informational texts independently and proficiently.

College and Career Readiness Anchor Standards for Writing (K-12) (Extension Activities only)

Text Types and Purposes 1: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

Text Types and Purposes 2: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

Production and Distribution of Writing 4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Production and Distribution of Writing 6: Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge 8: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

Research to Build and Present Knowledge 9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

College and Career Readiness Anchor Standards for Language (K-12)

Language 1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

Vocabulary Acquisition and Use 6: Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing,

speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

College and Career Readiness Anchor Standards for Speaking and Listening (K-12)

Comprehension & Collaboration 1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

Comprehension & Collaboration 2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Presentation of Knowledge 4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

NEXT GENERATION SCIENCE STANDARDS (NGSS)

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ESS3-3: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including costs, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

NATIONAL CURRICULUM STANDARDS FOR SOCIAL STUDIES – NATIONAL COUNCIL FOR THE SOCIAL STUDIES (NCSS)

Theme 1: Culture

Theme 3: People, Place, and Environments

Theme 5: Individuals, Groups, and Institutions

Theme 6: Power, Authority, and Governance

Theme 7: Production, Distributions, and Consumption

Theme 8: Science, Technology, and Society

Theme 10: Civic Ideals and Practices

COLLEGE, CAREER & CIVIC LIFE (C3)

Dimension

D4.1.6-8: Construct arguments using claims and evidence from multiple sources, while acknowledging the strengths and limitations of the arguments.

D4.6.6-8: Draw on multiple disciplinary lenses to analyze how a specific problem can manifest itself at local, regional, and global levels over time, identifying its characteristics and causes, and the challenges and opportunities faced by those trying to address the problem.

D4.6.9-12: Use disciplinary and interdisciplinary lenses to understand the characteristics and causes of local, regional, and global problems; instances of such problems in multiple contexts; and challenges and opportunities faced by those trying to address these problems overtime and place.

D4.7.6-8: Assess their individual and collective capacities to take action to address local, regional, and global problems, taking into account a range of possible levers of power, strategies, and potential outcomes.

D4 .7.9-12: Assess options for individual and collective action to address local, regional, and global problems by engaging in self-reflection, strategy identification, and complex causal reasoning.

NATIONAL STANDARDS FOR MUSIC EDUCATION – NATIONAL ASSOCIATION FOR MUSIC EDUCATION (NAFME)

Core Music Standard: Responding

Interpret: Support interpretations of musical works that reflect creators' and/or performers' expressive intent.

Evaluate: Support evaluations of musical works and performances based on analysis, interpretation, and established criteria.

Core Music Standard: Connecting

Connecting 11: Relate musical ideas and works to varied contexts and daily life to deepen understanding.

RESOURCES

HANDOUTS

- Handout 1 - Filtering Experiment Observations
- Handout 2 - "Lead Poisoning and Health"
- Handout 3 - "Why didn't Flint treat its water? An answer, at last."