

8th Grade Science Unit 1: Colossal Collisions

Pop-Out 1: What is a Scientist?

Pop-Out Essential Question: *What makes a person a scientist or engineer?*

Introduction

The pop-outs are designed to provide a two to three day lesson that allows students to apply what they’ve learned in the unit to delve deeper into the intersection of social justice and science. The pop-outs explore concepts like identity in scientists and engineers, complexities and context in science, ethical considerations for scientists, and the role of environmental justice in science. They are intertwined with, yet independent of, many unit concepts. Within each pop-out, we provide a recommendation of when to use the pop-out within the unit. By utilizing equitable group work, the pop-outs will support the development of skills and mindsets cultivated in the units.

In this pop-out specifically, students will grapple with what characteristics make a scientist or engineer. Students will have the opportunity to explore their prior conceptions about scientists and learn about various scientists with different backgrounds, contexts, and narratives. Students can then reevaluate their beliefs and attitudes regarding what makes a scientist or engineer. Through this, students will be exposed to unique scientific careers, reflect upon the history of science, and apply their own science learning. Providing diverse examples of notable scientists will support all students in seeing themselves as scientists and engineers.

We recommend completing the pop-out after you have completed Unit 1. Because the pop-out highlights scientists whose work has directly contributed to our understanding of motion or collisions, students’ understanding of the unit content will support the pop-out learning outcomes.

Alignment Table

<p>Content</p> <ul style="list-style-type: none"> • There are many varied peoples and diverse careers contributing to scientific advancement. • Examining historical context is useful to understand scientific and technological advancement.
<p>Understandings about the Nature of Science (from NGSS Appendix H)</p> <ul style="list-style-type: none"> • Science knowledge is cumulative and many people, from many generations and nations, have contributed to science knowledge. • Science is a way of knowing used by many people, not just scientists. • Men and women from different social, cultural, and ethnic backgrounds work as scientists and engineers. • Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism and openness to new ideas.
<p>Science, Technology, Society, and the Environment (from NGSS Appendix J)</p> <ul style="list-style-type: none"> • The uses of technologies are driven by people's needs, desires and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. • Technology use varies over time and from region to region.
<p>Equity and Group work</p> <ul style="list-style-type: none"> • Work together to analyze, evaluate and interpret information. • Work together to plan and present information about a notable scientist or engineer.
<p>Language</p> <ul style="list-style-type: none"> • Orally communicate their findings about the history and accomplishments of notable scientists.

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- Engage with written resources.
- Answer questions in written format.
- Communicate ideas in class-wide discussions.

Learning Goals

In this task, students will use case studies to engage with what makes a scientist or engineer. More specifically, students will:

- Engage with their preconceptions of what makes a scientist.
- Explore a case study to investigate the life, context, history, and work of a notable scientist or engineer.
- Explain their case to other students through a presentation.
- Evaluate what makes a scientist by applying their knowledge to other groups' case studies.
- Reflect on their own science education and passions.

Content Background for Teachers

In this pop-out, students are asked to grapple with what characteristics, attributes, skill sets, or contributions make a scientist. Scientists with specific identity markers are often represented disproportionately in history. For example, history texts are rife with examples of white, male scientists and engineers. However, those scientists are not inclusive of the people who have contributed to scientific advancement. It is important for students to realize that science and engineering are incredibly diverse fields. Scientists come from various, varied backgrounds that enhance their scientific contributions. Students engage with case studies to help widen the historically narrow view of scientists and engineers. By expanding this view, all students may be able to see themselves as scientists or engineers and feel empowered to pursue a career in a scientific field.

Academic Vocabulary

- Scientist
- Engineer

Time Needed (Based on 45-Minute Periods)

2 Days

- Engage: 0.5 period
- Explore: 0.25 period
- Explain: 0.5 period
- Elaborate: 0.25 period
- Evaluate and Reflection: 0.5 period

Materials

- Unit 1, Pop-Out Student Version

Explain

- Case studies (1/student by group)

Elaborate

- Presentation materials (google slides and computers OR posters and markers – per group)

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Instructions

Engage

1. As a class, read the paragraph at the top of the student guide to introduce students to this pop-out.
2. You may also want to introduce the Engage by reading the instructions aloud.
 - The purpose of this activity is to engage students’ prior conceptions about scientists.
3. Once complete, divide students into partners. Prompt students to discuss their drawing with a partner.
4. Lead the students through a brief class discussion that results in a class-wide working definition of a scientist and an engineer. It may be useful to pose leading questions, like: *What did you and your partner’s scientists/engineers have in common? What type of work does a scientist/engineer do? What do you see in a scientist’s/engineer’s environment?*
 - The class definition of a scientist and engineer does not need to be precise, however it should express some components of science and engineering. Below are possible examples:

What is a scientist and what do they do?	<ul style="list-style-type: none"> ● Conduct experiments ● Learn about the world ● Use the scientific method to test a hypothesis
What is an engineer and what do they do?	<ul style="list-style-type: none"> ● Make, test, or analyze machines ● Use materials to make machines ● Build airplanes, rockets, etc.

Explore

1. Provide each group with a case study reading (1/student). There are three case studies in total: Isaac Newton, Mary Golda Ross, and Luis Walter Alvarez. This sets the stage for students to jig-saw with other groups later in the pop-out.
2. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Reporter, Harmonizer.
 - Ask Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to handle any resources needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Reporter to make sure the group is taking notes in the table and collecting evidence from their case study that may be used in their presentation.
3. Ask students to use annotation strategies (whatever you use in your classroom regularly) to read and analyze their case study as a group. You may want to review the instructions on their student guide as a class before beginning the activity.

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4. In their student guides, students should fill out the graphic organizer chart for their case study, making sure to provide multiple examples. Each student has only one graphic organizer in this section in his or her student guide (as they are completing only one case study at this point in the pop-out). However all three have been provided here for your reference:

Person	Information	What contributions did they make to scientific advancement?
<p>Isaac Newton</p>	<p>Where did they do their work? Attended University on and off, however did most of his work outside and in atypical environments</p> <p>What kind of work did they do? Studied gravity, Newton’s laws, light and telescopes</p> <p>What was their personality like? Struggled to make friends or be happy Difficulty in school Typically worked alone</p> <p>What did they look like? English male</p> <p>Where did they come from? Cambridge, England</p>	<p>What work did they do that we use today? Newton’s concepts of gravity are still used today. Also used today are his three laws (law of inertia, law of acceleration, law of action and reaction). He hypothesized that white light is made of all colors of light, an idea that remains true today. Newton also made a telescope that used mirrors.</p> <p>What work did they do that relates to motion or collisions? Newton’s laws and his ideas about gravity are useful when thinking about motion and collisions.</p>
<p style="text-align: center;">Is this person a scientist or engineer?</p> <p>Yes</p> <p style="text-align: center;">What characteristics make this person a scientist or engineer? What did they do that makes them a scientist or engineer?</p> <p>Newton’s research findings continue to impact society and science today. Additionally, he had curiosity that led to a lot of exploration, research, observations, questioning, and inventing.</p>		

Person	Information	What contributions did they make to scientific advancement?
<p>Mary Golda Ross</p>	<p>Where did they do their work? Worked in New Mexico and with Lockheed Aircraft Corporation</p> <p>What kind of work did they do? Worked on the P-38 fighter plane, engineered ballistic missiles, developed rockets</p>	<p>What work did they do that we use today? Ross’s work with planes, missiles and rockets are still used in technology today. The reports she wrote for NASA are still used. Given that much of the work she did in the top-secret think-tank is still classified, we do not know all the ways her work is still impacting us.</p>

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	<p>Worked in a top-secret think tank Wrote handbooks for NASA that informed space travel</p> <p>What was their personality like? Was well-liked by peers and supervisors (top 10%)</p> <p>What did they look like? A Native American woman from the Cherokee Nation</p> <p>Where did they come from? Cherokee Nation in Oklahoma</p>	<p>What work did they do that relates to motion or collisions? Ross’s work directly contributed to space travel. Her work paved the way for us to have rockets that could be used to change the course of an object in space.</p>
	<p>Is this person a scientist or engineer?</p> <p>Yes</p> <p>What characteristics make this person a scientist or engineer? What did they do that makes them a scientist or engineer? Ross’s work in space science has set the stage for much of our understanding of space. Her work is still used today. She worked with many materials and machines, so she was an engineer.</p>	

Person	Information	What contributions did they make to scientific advancement?
<p>Luis Walter Alvarez</p>	<p>Where did they do their work? He worked at various laboratories (Radiation Laboratory, MIT, Manhattan Project)</p> <p>What kind of work did they do? Worked on airplane transmission technology, the plutonium bomb, an instrument that measures bomb strength, and developing a theory about the dinosaur extinction</p> <p>What was their personality like? No notable description</p> <p>What did they look like? A spanish male</p> <p>Where did they come from? San Francisco, CA</p>	<p>What work did they do that we use today? Alvarez made contributions to wartime efforts through airplane transmission technology, the plutonium bomb, and an instrument that measures bomb strength.</p> <p>What work did they do that relates to motion or collisions? Alvarez founded a theory about a massive collision that led to the dinosaur extinction.</p>

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	<p>Is this person a scientist or engineer?</p> <p>Yes</p> <p>What characteristics make this person a scientist or engineer? What did they do that makes them a scientist or engineer?</p> <p>Alvarez’s varied scientific discoveries and inventions have impacted society significantly (e.g. aircraft travel transmissions). He was awarded a nobel prize for his contributions.</p>
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Explain

1. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Reporter, Harmonizer. It may be useful to assign roles that differ from the roles students held in the Explore.
 - Ask Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to handle any resources needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Reporter to make sure the group is including everything in their presentation materials.
2. Working in their groups, students will prepare a 1-2 minute presentation about their case study person. Be sure to explain that they need to present sufficient information for their classmates to determine if this person is a scientist or engineer. Thus, the presentation will need to include all information they gathered from the case study and recorded in the graphic organizer. Remind students that the goal of their presentation is to clearly convey information. Visual aids can support this outcome greatly.
3. Once groups have had sufficient time to prepare their presentation and presentation materials, begin the jigsaw. A group that had the Isaac Newton case study should be added to a group who read the Mary Golda Ross case study and a group that worked with the Luis Walter Alvarez case study. Thus, there will be three different case study groups within each new, larger group.
4. Provide instructions for which case study will present first within each larger group. It is recommended to have a consistent order throughout the classroom – e.g. Isaac Newton presentation first, Mary Golda Ross presentation second, Luis Walter Alvarez presentation third. Remind students that each group has 1-2 minutes to present and that audience members should be taking notes in the charts on their student guides.
5. You may want to circulate during the presentations to see how students are engaging with the material, using public speaking skills, and gathering information as an audience member.

Elaborate:

1. This section of the pop-out asks students to apply what they have learned about a scientist to two case studies presented to them. Have the large groups (of three case studies) break apart into their original groups.

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2. Ask each group to discuss the two case studies presented to them. It is not important for students to come to the same conclusion. As long as students are using evidence to support their opinion, they may disagree. The question underpinning their discussion is: *Is this person a scientist or engineer? What characteristics make this person a scientist or engineer? What did they do that makes them a scientist or engineer?*
3. It may be useful to circulate during this process. You can provide probing questions as needed to push the students in their thinking about scientists: *What is this person known for? What work did they do? How does their work fit with our class definition of a scientist/engineer? How did they act like a scientist/engineer? What did they do that makes them a scientist or engineer?*

Evaluate

1. Students independently work to answer the reflection questions in their student guide. Read the instructions aloud to students, suggesting that they refer to their initial engage activity to recall their prior conception of a scientist.
2. There are no right answers, but encourage students to look back at their work in their student guides. They should not change their initial responses in the student guide, but rather use this space to reflect on their original idea and add evidence they have collected over the course of this task.
3. Bring the whole class together for a group discussion. Briefly address class behavior norms for class discussions. You may use equity sticks to facilitate this process.
 - Begin the discussion by asking students: What do you believe makes a scientist or engineer?
 - You may use subsequent prompts such as: What about the scientists or engineers surprised you? Can you think of examples of scientists or engineers you know? Do you believe we are acting as scientists or engineers in this class?

Assessment

1. You may collect the student guide handout and assess using:
 - *Criteria of your choice.* We recommend focusing on the reflection questions from the Evaluate section to provide a sense of how students view scientists and engineers.
 - This can be a formative tool to look for trends in student demonstrations of skills and practices. You can then use this formative data to inform future instruction.

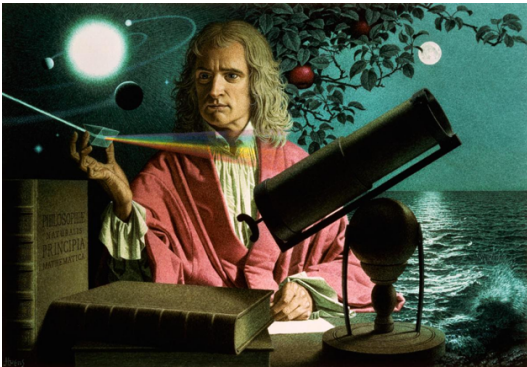
Isaac Newton

Explore Case Study

In this unit, you learn about Isaac Newton and how his laws can help us understand how to alter the course of *Etiam*. Newton is often called the “grandfather of gravity”. He is considered one of the most influential minds of his time. But even though we learn about Newton’s ideas in science class these days, he wasn’t always popular.

In England in 1642, Newton was born to a single mother. From a young age, he constructed models and engineered solutions to problems he encountered, like making a mouse-powered flour mill. However, he didn’t shine in school and generally preferred to work and study alone. He struggled to remain happy, often lashed out at friends and family, and was frequently described as an unlikable character.

He hit a turning point in June 1661 when he attended Cambridge University. After graduating in 1665, Newton was forced to return home for two years because a bubonic plague epidemic temporarily closed the school. He describes this time period as some of the most important years



of his career. It was during this time, in 1666, that he saw an apple fall from a tree. He wondered why the apple fell directly to the ground instead of upward or to the side. This observation planted the seed for his life-long exploration of gravity. This is representative of how he did most of his science outside.

He later returned to university where he worked on and off as a researcher and professor throughout his life. Newton is credited with his three laws of motion that scientists still believe today: the law of inertia, the law of acceleration, and the law of action and reaction.

Newton explored topics over a wide range of math and science disciplines. Through an interest in studying light, he hypothesized that white light is made of all colors of light (an idea that remains true today). He turned his attention toward the skies, too. He spent years observing the motion

of moons and planets and applying those observations to inform his notion of gravity. To help with this, he developed a telescope that relied on mirrors to make crisp, clear images of the skies.

In 1677 and 1693, Newton was affected by significant mental health challenges. These may have been caused by stress, the loss of friends and family, or chronic mercury poisoning from years of alchemy (the study and use of metals). Despite his challenges, Newton's scientific work is still used today in many significant ways.

Sources:

- <https://www.psi.edu/epo/ktimpact/ktimpact.html>
- <https://web.stanford.edu/~buzzt/gravity.html>
- <https://www.sciencenewsforstudents.org/article/dinosaurs-extinction-asteroid-eruptions-doom>

Mary Golda Ross

Explore Case Study

In the early 1900s, very few women rose into powerful positions in the workforce. Mary Golda Ross is an exception. Born in 1908 on the Cherokee Nation in Oklahoma, Mary faced a lot of challenges. During this time, many groups of people were discriminated against, especially people of color, like Native Americans, and women. Despite being discriminated against as a Native American woman of color, Mary was a woman whose contributions and accomplishments continue to shape the scientific community.

Mary's great-great grandfather, John Ross, was the longest-serving chief of the Cherokee Nation. He served as the chief during the Trail of Tears (the Trail of Tears is the name for a time when the Indian Removal Act forced many indigenous (Native American) tribes to migrate from their ancestral lands in the American southeast to lands west of the Mississippi River). Much of Mary's life was dedicated to supporting Indigenous communities through work she did after college and toward the end of her career.

After childhood, Mary's education and career took flight. Studying math, Mary graduated from Northeastern State College. She worked for the Bureau of Indian Affairs and Native American boarding schools in New Mexico. At that point, Mary decided to pursue her interest in engineering by getting a Master's Degree from the University of Northern Colorado. Engineering is the study of



inventing, building or testing machines or their materials. In 1942, shortly after graduation, she accepted a position with Lockheed Aircraft Corporation.

Spurred by the ongoing WWII, Mary and her team worked on a fighter plane (P-38 lightning fighter) that travelled at very high speeds. Because of the newness of the technology, engineers were concerned that the plane would break down when moving so quickly in certain flight patterns. Mary and a team of other engineers and mathematicians prevented the problem.

Shortly after that accomplishment, Mary took courses in aeronautical engineering from UCLA. She continued to work her way up the professional ranks. After a number of years, she was invited to join a top-secret think tank. Much of the work completed there remains classified (secret) to this day. Within that task force, a team worked together to write handbooks to inform NASA about space travel. Mary's work also included engineering ballistic missiles and developing rockets. Mary was well-liked and respected by peers throughout her career. One of her supervisors believed that Mary was in the top 10% of engineers he'd ever seen.

In 1973, Mary retired from her senior engineer position. She continued advocating on behalf of Native Americans in her positions with the Council of Energy Resource Tribes and the American Indian Science and Engineering Society.

Sources:

- <https://www.smithsonianmag.com/smithsonian-institution/little-known-math-genius-helped-america-reach-stars-180962700/>
- <http://blog.nmai.si.edu/main/2009/10/mary-g-ross-blazed-a-trail-in-the-sky-as-a-woman-engineer-in-the-space-race-celebrated-museum-.html>
- <https://news.engin.umich.edu/2017/06/remembering-mary-golda-ross/>

Luis Walter Alvarez*Explore Case Study*

Luis Walter Alvarez was born in 1911 in San Francisco, CA to two parents who emigrated from Spain. He moved a lot during his childhood for his father's work. This trend continued during his adult life as he moved to take different career opportunities.

Luis received a PhD in physics from University of Chicago in 1936. After that point, he worked at the Radiation Laboratory at University of California in Berkeley. Working together with a team of scientists, Luis developed experiments to observe and capture electrons (very small parts of atoms) to show radioactivity. Their work led to many new scientific theories. By the early 1940s, WWII was underway and impacting the entire American public. This was true for Luis, too. In fact, Luis' next job was in a laboratory at Massachusetts Institute of Technology (MIT) that was designed to research items for the military. Two notable discoveries that came from this lab: transponders (wireless devices that give and receive electrical signals) and radar system technology. These led to the creation of a communication system between airplane pilots and ground control traffickers. It allowed ground control to guide pilots to landing. In 1945, Luis was awarded the National Aeronautic Association's Collier Trophy for this achievement.

As the war continued, Luis worked at Los Alamos on the Manhattan project. In his time there, he mostly worked on designing the "Fat Man" plutonium bomb. He also developed microphone/transmitters that could be dropped from a moving plane to send information about the strength of an atomic explosion to scientists. These allowed scientists to capture data to learn about the strength of a bomb without having to be there in person. Luis flew as a scientist in the bomb droppings of both Hiroshima and Alamogordo.

Luis continued exploring subatomic (smaller than atoms) and atomic particles in application to various scientific fields throughout his life. Toward the end of his career, in 1970s and 1980s, Luis worked with his son Walter Alvarez and two co-workers Frank Asaro and Helen Michel. By studying Limestone (a type of rock) in Italy, the group



developed a theory to explain the extinction of the dinosaurs! At the time, they received strong criticism from the larger scientific community – people did not believe them. Ten years later the Chicxulub (evidence of an impact from a large crater) was discovered and supported their theory. Luis received a Nobel Prize for his body of work.

Sources:

- https://www.nobelprize.org/nobel_prizes/physics/laureates/1968/alvarez-bio.html
- http://ethw.org/Luis_Walter_Alvarez

8th Grade Science Unit 2: Travelling Through Space
Pop-Out 2: How Power Influences Science

Pop-Out Essential Question: *How do scientific ideas change and who has the power to change them?*

Introduction

Using what students have learned about the solar system as a foundation, this pop-out provides an opportunity for students to dive into the iterative nature of science by exploring how science changes and who has the authority to effect change. Through structured research and the creation of a video, they will grapple with cases of scientific controversies throughout history (flat vs. round Earth, Heliocentric vs. Geocentric solar system model) that build cohesively upon the unit content. They will then use these skills and apply their learning to a current-day climate change scenario. As students often believe science is a fixed, factual entity, this pop-out will allow students to expand their views of how science changes and what factors influence those changes.

We recommend using this pop-out at the end of Unit 2, as it builds upon students understanding of the solar system. Since students explore concepts using the content of climate change in Unit 3, this pop-out also provides them with a transition to that content.

Alignment Table

<p>Content</p> <ul style="list-style-type: none"> • The shape of the Earth and the organization of our solar system are examples of historical controversies. • The causes of Climate Change are still disputed today. • Examining historical context is useful to understanding the nature of science.
<p>Understandings about the Nature of Science (from NGSS Appendix H)</p> <ul style="list-style-type: none"> • Science depends on evaluating proposed explanations. • Scientific values function as criteria in distinguishing between science and non-science. • Science knowledge is based upon logical and conceptual connections between evidence and explanations. • Scientific explanations are subject to revision and improvement in light of new evidence. • The certainty and durability of science findings varies. • Science findings are frequently revised and/or reinterpreted based on new evidence. • Theories are explanations for observable phenomena. • Science theories are based on a body of evidence developed over time.
<p>Science, Technology, Society, and the Environment (from NGSS Appendix J)</p> <ul style="list-style-type: none"> • Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. • Science and technology drive each other forward.
<p>Equity and Group work</p> <ul style="list-style-type: none"> • Work together to analyze, evaluate, and interpret information. • Work together to create a mini-video.
<p>Language</p> <ul style="list-style-type: none"> • Engage with a variety of written and spoken resources. • Connect visual representations to verbal and written explanations. • Orally communicate information and a stance in a video.

8th Grade Science Unit 2: Travelling Through Space

Pop-Out 2: How Power Influences Science

Learning Goals

This pop-out asks students to engage with examples, research, and scenarios to develop a broad understanding of how science changes and how it can be affected by those with power. More specifically, the purpose is to:

- Engage students' knowledge of the solar system and the shape of the Earth to set the stage for examining scientific controversies.
- Conduct research to examine the historical context and controversy of the Heliocentric vs. Geocentric solar system models.
- Create a video to explain a scientific controversy.
- Use knowledge to explain why climate change is a current-day controversy.
- Apply knowledge of the changing nature of science to reflect on the role of skepticism in their roles as scientists moving forward.

Content Background for Teachers

Science is a constantly changing paradigm. The scientific cannon is responsive to emerging discoveries, new information about past discoveries (e.g. a study not being reproducible), and what research questions are funded. Throughout history, there are numerous cases of a scientific discovery that were deemed preposterous at first glance. The beliefs of people in power and the general public greatly influence what ideas are immediately embraced. For example, the Catholic Church has historically held vast amounts of political and social power through thousands of devout followers; thus, religion is a power that has influenced science over the years. The shape of the Earth, the organization of the solar system, and evolution all exemplify this notion (For more information about the different controversies explored in this pop-out, see the resources provided to students). However, as time progresses and evidence mounts in support of a scientific idea, it is frequently adopted into the scientific cannon. This begs the questions: how does science change? What factors affect the adoption of a scientific idea? How does power play a role in science?

When examined through a historical lens, exploring past scientific controversies can shed light on some of these questions. This sets a foundation of measured skepticism in application to current and future science. For example, in scientific research today, bias is rampant in what research questions are funded. While funding sources vary greatly within scientific fields, 75% of medical clinical trials in the United States are funded by private corporations who often have a stake in the research product. Money often holds power in present-day society. As the relationship between science and power continues, cultivating a skeptical habit of mind is important for students.

Sources:

- https://undsci.berkeley.edu/article/who_pays

Academic Vocabulary

- Heliocentric
- Geocentric
- Climate change
- Myth

**8th Grade Science Unit 2: Travelling Through Space
Pop-Out 2: How Power Influences Science**

Time Needed (Based on 45-Minute Periods)

3 Days

- Engage: 0.5 period
- Explore: .75 period
- Explain: .75 periods
- Elaborate: 0.5 period
- Evaluate and Reflection: 0.5 period

Materials

- Unit 2, Pop-Out Student Version

Explore

- Computer or tablet (1/group)

Explain

- Video camera or phone (1/group)

Elaborate

- Unit 2, Pop-Out Scenario (1/student)

Instructions

Engage

1. To introduce the pop-out, we recommend reading the student guide introduction aloud to the class.
2. Individually, have students answer the four questions on their student guide. They are designed to prime students for the coming task, pique their interest, and help you assess their prior knowledge.
 - Emphasize to students that they should use what they already know to answer the questions, and it is okay if they don't know the answers.
3. In pairs, have students read the short passage about the historical context of when people believed the earth was flat and the process that has led to the widely accepted scientific theory that the earth is spherical. Have students complete their graphic organizer (see below) based on the reading.
4. As a class, share ideas of each question in a class-wide discussion. The use of equity sticks is encouraged for more equitable participation in class-wide discussions like these (See "How To Use This Curriculum" for more details). By the end of the discussion, the class should have a general understanding of the flat vs. round Earth controversy.

What was the original idea? What is the evidence?	Many people originally thought that the Earth was flat. People knew this by listening to: myths, stories in the Bible, European explorers.
What is the new idea? What is the evidence?	The new scientific idea is that the Earth is roughly spherical. Possible observations/evidence include: <ul style="list-style-type: none"> ○ The rotation of the stars and planets around the earth ○ A ship disappears over the horizon in stages – the hull (bottom) disappears first, while the sails and mast (top) remain visible longer. ○ NASA's images and measurements from space

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Pop-Out 2: How Power Influences Science



<p>Why was there a controversy? <i>Hint: Who originally believed the Earth was flat? How many people believed the Earth was flat?</i></p>	<p>This is a complex thought process. Students may need support in discerning possible answers. It boils down to the number of people who believe something and how much power those people have.</p> <ul style="list-style-type: none"> ○ For many years, historical stories held to the idea that the Earth was flat. Mythology was widely accepted. ○ People who believed in the literal translation of the Bible believed the Bible’s stories that the characters traveled on a flat Earth. There were many people who believed in the Christian faith, so the Christian church held a lot of power. If stories in the Bible were not scientifically viable, it would cast doubt on the power of the Bible. This was in conflict with the scientific findings regarding the shape of the Earth.
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Explore

1. Students have examined one historical controversy by identifying the original and new ideas, explaining the evidence for each idea, and exploring the context of the change (i.e. who held power). Now, they’ll expand on these skills by applying the same concepts to the Heliocentric and Geocentric solar system models.

2. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Recorder, Harmonizer.
 - Ask the Facilitator to read the directions, make sure everyone understands the task, and facilitate research.
 - Ask the Materials Manager to handle any resources needed to complete the task, including computers.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Recorder to make sure the group is recording their observations and conclusions in their student guide.

3. Ensure each student group has a space to conduct their research.
 - Walk around and listen to the kind of evidence students are discussing. Try not to provide any explicit analysis, but you may point out parts of the information to focus on if students are struggling.
 - Students should fill out the research tables in the student guide to organize and record their research. For students who need more support in the research process, a differentiated version of the graphic organizers is provided below (followed by an answer key).

<p>Source 1: Prior Solar System Knowledge (Geocentric Model) Video</p>
<p>Keeping in mind what you have learned about the solar system, watch the video. Carefully type the following url into your browser: (https://vimeo.com/6397716).</p>
<p>1. What do you notice about how the planets and sun are arranged in the video?</p>

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2. Do you believe this is how the solar system works?

Why or why not?

Source 2: Heliocentric vs. Geocentric Models Video

This will explain the differences between the Heliocentric and Geocentric solar system models. Carefully type the following url into your browser: (<https://www.youtube.com/watch?v=iiBIFlvu-X0>).

1. What is the geocentric model?

2. Why did people believe it? What was their evidence?

3. What is the heliocentric model?

4. Why do people believe it? What is the evidence?

Source 3: Heliocentric vs. Geocentric Models Article

Check out this article on the models. Keep in mind what you have already learned from watching the videos. Carefully type the following url into your browser:

<https://www.universetoday.com/36487/difference-between-geocentric-and-heliocentric/>

1. In the 15th and 16th centuries, scientists were noticing problems with the geocentric model. What were they?

2. Who proposed the idea of the heliocentric model? What evidence/observations did he have?

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Source 4: The Controversy of the Heliocentric Model Article
Take your time to read through this article explaining the consequences of introducing the Heliocentric model. Carefully type the following url into your browser: http://newsroom.ucla.edu/releases/the-truth-about-galileo-and-his-conflict-with-the-catholic-church
1. Who had power that fought against the heliocentric model? Why?
2. Why was Galileo imprisoned?

Answer Keys

Source 1: Prior Solar System Knowledge (Geocentric Model) Video
Keeping in mind what you have learned about the solar system, watch the video. Carefully type the following url into your browser: (https://vimeo.com/6397716).
1. What do you notice about how the planets and sun are arranged in the video? Students should notice that the Earth is in the center of the solar system and that the planets and the sun are revolving around the Earth.
2. Do you believe this is how the solar system works? Building upon prior knowledge of the solar system (from Unit 2), students should be skeptical of the model. Why or why not? They should be able to explain that the sun is at the center of the solar system, and that the planets rotate around the sun. The video shows the Earth at the center of the solar system; therefore the video is not accurate.

Source 2: Heliocentric vs. Geocentric Models Video
This will explain the differences between the Heliocentric and Geocentric solar system models. Carefully type the following url into your browser: (https://www.youtube.com/watch?v=iiBIFlvu-X0).
1. What is the geocentric model? The geocentric model is how humans thought the solar system was organized, with the Earth at the center of the solar system.
2. Why did people believe it? What was their evidence? People saw stars and planets stay in one place and position every night. Every night stars stayed in position but changed places, while planets changed place and position all together.
3. What is the heliocentric model? The sun is in the center of the solar system and planets orbit around it.
4. Why do people believe it? What is their evidence? Current day technology, like telescopes, show that the sun is in the center of the solar system.

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Source 3: Heliocentric vs. Geocentric Models Article

Check out this article on the models. Keep in mind what you have already learned from watching the videos. Carefully type the following url into your browser:

<https://www.universetoday.com/36487/difference-between-geocentric-and-heliocentric/>

1. In the 15th and 16th centuries, scientists were noticing problems with the geocentric model. What were they?

Scientists started to notice inaccuracies in predicting eclipses. They also determined that the calendar used to predict equinoxes was not accurate. Additionally, sometimes Mars seemed to move backwards then forwards.

2. Who ultimately proposed the idea of the heliocentric model? What evidence/observations did he have?

In the third century BCE, Aristarchus of Samos proposed the heliocentric model. However no one listened for several centuries until Nicolaus Copernicus suggested the idea in the 15th century (though Galileo made the idea popular). The movement of planets fit well with the model. For example, the model explains why Mars seemed to travel backwards (since it has a smaller orbit than Earth). Kepler and Newton added work that supported the model.

Source 4: The Controversy of the Heliocentric Model Article

Take your time to read through this article explaining the consequences of introducing the Heliocentric model. Carefully type the following url into your browser:

<http://users.sussex.ac.uk/~desw/galileo/life/eands.html>

1. Who had power and fought against the heliocentric model? Why?

The Catholic church was the main institution that fought against the heliocentric model. Because parts of the Bible talk about humans traveling on a flat earth, a new solar system model may be in conflict with the teachings of the Bible.

2. Why was Galileo imprisoned?

Galileo was imprisoned by Pope Paul V for believing in the Heliocentric model. He served his sentence in his home for the rest of his life.

Explain

1. Students can then use all the information they have gathered to make a mini-video explaining the Geocentric vs. Heliocentric controversy.
2. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Harmonizer, and Reporter. It may be beneficial to assign each student a different role than they had in the Explore.
 - Ask the Facilitator to read the directions, make sure everyone understands the task, and facilitate the video-making process.
 - Ask the Materials Manager to handle any resources needed to complete the task, including computers and recorders.

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- Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Reporter to make sure the group is reporting all of the pertinent research in their video.
3. First, have students brainstorm how they want to convey information in their movie. You may suggest they model their movie after a MythBusters episode.
 - We highly recommend students develop a plan on their student guides before moving on to record a video. If desired, you may require students to submit these plans as a checkpoint before moving on to video recording.
 4. Ask the groups to make a mini-video, ensuring they include information from 2-3 of the sources they researched. Their video should answer the questions: Why did people have different ideas about the organization of the solar system? Why was there a controversy? What led to the acceptance of the Heliocentric model?
 5. Once complete, select one video to show to the class.

Elaborate

1. This last scenario takes what they have learned and applies it to a current-day scenario that they may find quite useful and relevant to current politics. Using the *Unit 2, Pop-Out Scenario* handout and their student guide, students will engage with the science around climate change. Student answers may vary greatly; however they should be substantiated with clear evidence. Possible answers are included below.
2. We recommend students do this individually as it can allow students to show what they have learned, but student partners or student groups can provide scaffolding as necessary.

<p><i>What is the most common belief about climate change?</i></p> <ul style="list-style-type: none"> ● <i>What is the evidence for this belief?</i> ● <i>Who believes it and why?</i> 	The common belief is that climate change is caused by human behavior.
	The EPA report NASA data, studies, and reports NOAA supercomputers and models
	97% of scientists agree because of the evidence present in the science.
<p><i>What is the least common belief about climate change?</i></p> <ul style="list-style-type: none"> ● <i>What is the evidence for this belief?</i> ● <i>Who believes it and why?</i> 	The least common belief is that climate change is a part of the Earth’s natural cycle, unrelated to human activity.
	The Earth has warmed about three degrees in the last 300 years.
	Fox News and some big businesses. This is because big businesses could lose money if they had to decrease their greenhouse gas emissions.
<p><i>Why is there a controversy?</i></p>	There is a controversy because two different groups believe very different things about climate change.

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<ul style="list-style-type: none"> ● Who is resisting the belief that climate change is real? ● Who holds the power to resist? ● What is motivating them to resist? 	Big businesses and some conservative people
	Big businesses
	Since businesses emit the majority of greenhouse gases, if they had to limit their emissions, they may stand to lose money. Thus, they want to keep running their businesses (even if that means they make greenhouse gases).

Evaluate

1. At the end of the task, ask students to reflect on what they have learned over the course of this pop-out by answering the following questions in their student guide:
 - Based on what you've learned about controversies, do specific people or groups have more power to change scientific beliefs? How can self-interests influence science? (*Hint: If a person or a company benefit from a current scientific belief, does that impact what science is accepted?*)
 - Do you think that there are scientific beliefs we hold now that could be changed in the future? Does what you've learned affect how you'll consider scientific discoveries or beliefs?
2. There are no right answers. Encourage students to look back at their work in their student guides. They should consider what they learned from the Engage, Explore, and Elaborate.
3. Bring everyone together for a class-wide debrief. The use of equity sticks is encouraged for more equitable participation in class-wide discussions like these (See "How To Use This Curriculum" for more details). Choose one of the questions to jumpstart a discussion about what they learned over the course of the pop-out. Encourage them to bring in examples from the cases.

Assessment

1. You may collect the student guide handout and assess using:
 - *Criteria of your choice.* We recommend focusing on the responses in the Elaborate section to see how students are using evidence.
 - This can be a formative tool to look for trends in student demonstrations of skills and practices. You can then use this formative data to inform future instruction.

The Controversy of Climate Change

Elaborate Scenario

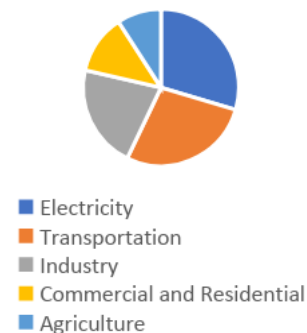
Have you heard about climate change before? It has been in the news, in science classrooms, and in politics a lot in the last couple of years as the climate change debate has heated up. Climate change is the idea that the Earth is getting warmer. Most people think that climate change is happening because of human activity whereas some people think that climate change is part of the Earth's natural cycle, unrelated to human activity.

According to 97% of scientists, the evidence that climate change is caused by human activity is very clear. Since the Intergovernmental Panel on Climate Change (IPCC) formed in 1988, the theory of climate change has been widely accepted by scientific organizations. For example, the Environmental Protection Agency (EPA) website (from January 2017) states that climate change is unquestionably taking place and humans are the main factor contributing to it. In 2016, the EPA released a report exploring many indicators of climate change. The report was made by a lot of different scientists. NASA has released data, studies, and reports that support the climate change theory. The National Oceanic and Atmospheric Administration (NOAA) has used supercomputers and models to help the population prepare for the coming effects of climate change.

On the other side of the debate sits the people who think climate change is not linked to human activity. Big businesses and some politically conservative people think this. Many climate change doubters say that there is not enough good science to prove the link between climate change and human activity. Instead, they think that climate change is a natural part of the Earth's climate changing over time. A reporter at Fox News said, "of course climate change is real! Climate changes -- it always has and always will. For the past 300 years, since 'the little ice age,' the globe warmed about three degrees. The warming started well before man emitted much carbon."

For those who see the link between climate change and human activity, greenhouse gases are blamed for the rising temperatures. Greenhouse gases are made when we burn fossil fuels. This happens when we use electricity, cars, factories, airplanes, ships, and other sources. In fact, worldwide greenhouse gas emissions come from: electricity (29%), transportation (27%), industry (21%), commercial and residential uses (12%), and agriculture (9%).

Percentage of Greenhouse Gases by Source



If so many scientists think that climate change is caused by humans making greenhouse gases, why do some people think that climate change is not linked to people? Let's consider who makes a lot of greenhouse gases and has power. Many big companies rely on the burning of fossil fuels to keep their business going. For example, automobile companies need to burn fossil fuels to make and assemble cars. In fact, two thirds of greenhouse gases are produced by just 90 companies in the world. Many of those companies make a lot of money. Lowering their greenhouse gas emissions may decrease business and lead to less profits. Some of these businesses spend money trying to pass laws to let them keep producing greenhouse gases. This is good for the companies - since they wouldn't have to worry about decreasing emissions - but harmful to the environment since those gases are believed to cause climate change.

Despite the overwhelming scientific support that climate change is caused by human activity, it remains a topic of debate in the public sphere.

Sources:

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- <https://climate.nasa.gov/evidence/>
- <http://www.noaa.gov/climate>
- <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>
- <https://hbr.org/2016/10/research-whos-lobbying-congress-on-climate-change>
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8th Grade Science Unit 3: Adapt or Die?
Pop-Out 3: Right, Wrong, and In-Between

Pop-Out Essential Question: *How do we decide what is most ethical in science?*

Introduction

By this point in the curriculum, students have engaged with a variety of scientific concepts and content, which gives them a strong foundational understanding of science. In this pop-out, students will build upon that knowledge and grapple with the role of ethics in science. Many scientific discoveries give birth to complex, nuanced ethical considerations. Through engaging with a few different cases of ethics in science related to the core content of Unit 3, students will consider questions of what is right and wrong and how they make these kinds of decisions. They will work with examples that do not have a straightforward answer, but instead have various pros and cons.

Students will continue building skills in evaluating, analyzing, and interpreting information from a variety of sources. They will use that to write clear and balanced accounts of an ethical problem. Through this process, students examine their own beliefs and consider the role of ethics in science. As these students are poised to become the next generation of scientists, it is valuable for them to consider their role in making ethical choices.

We recommend using this pop-out after Task 4 of Unit 3. The contexts of these ethical scenarios relate to students’ conceptual understanding of GMOs gained through Task 4.

Alignment Table

<p>Content</p> <ul style="list-style-type: none"> • There are complex ethics embedded into many different scientific discoveries and their applications (e.g. genetically modified crops, designer babies). • Considering the role of ethics in science is valuable in understanding the nature of science and a student’s role in science.
<p>Understandings about the Nature of Science (from NGSS Appendix H)</p> <ul style="list-style-type: none"> • Science depends on evaluating proposed explanations. • Science knowledge is based upon logical and conceptual connections between evidence and explanations. • The certainty and durability of science findings varies. • Science is cumulative and many people, from many generations and nations, have contributed to science knowledge. • Advances in technology influence the progress of science and science has influenced advances in technology. • Scientific knowledge is constrained by human capacity, technology, and materials. • Science knowledge can describe consequences of actions but is not responsible for society’s decisions.
<p>Science, Technology, Society, and the Environment (From NGSS Appendix J)</p> <ul style="list-style-type: none"> • Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

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- The uses of technologies are driven by people’s needs, desires, and values, by the findings of scientific research, and by differences in such factors as climate, natural resources, and economic conditions.

Equity and Group work

- Work together to analyze, evaluate, and interpret information.
- Discuss with peers to learn about other perspectives while examining ethically ambiguous situations.

Language

- Use annotation strategies to dissect text.
- Communicate ideas verbally in class discussions.
- Communicate multiple perspectives within an ethical dilemma in writing.
- Incorporate evidence to support a written argument.

Learning Goals

This pop-out asks students to examine multiple perspectives of a couple ethical dilemmas to consider the ethical complexities that accompany scientific advancements. More specifically, the purpose is to:

- Engage students’ through an imaginary case study.
- Analyze a text to examine the various factors of Zambia accepting or rejecting genetically modified food aid when in a food crisis.
- Generate an opinion on the Zambia food crisis and share ideas in a class discussion.
- Apply understandings to the case of designer babies.
- Evaluate the ethics of GMOs, such as crops and designer babies, through a writing assignment.

Content Background for Teachers

Ethics underpin scientific research and the applications of research and technology in society. Institutional Review Boards strive to ensure research is conducted within ethical bounds; however, as scientific discoveries and technologies emerge, ethical dilemmas are born regardless. How a scientific discovery impacts different groups of people or the environment is an important component of how to manage a discovery. There are many complex ethical dilemmas facing us today. For example, with the rise of modifying genes, how will we manage designing babies? For more information on specific ethical debates, refer to the student learning materials.

Academic Vocabulary

- Ethics
- Genetically Modified Food
- Genetically Modified Organism
- Dilemma
- Designer Baby
- Food Aid
- Words within CNN article (while these are not vital for learning in the pop-out, students may need additional support to understand the following words in the context of the article): Embryo, In Vitro Fertilization, karyomapping, alteration, inheritable genetic modification

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Time Needed (Based on 45-Minute Periods)

3 Days

- Engage: 0.5 period
- Explore: 0.5 period
- Explain: 0.5 periods
- Elaborate: 1 period
- Evaluate and Reflection: 0.5 period

Materials

- Unit 3, Pop-Out Student Version

Explore

- Unit 3, Pop-Out Zambia Article (1/student)

Elaborate

- Unit 3, Pop-Out Designer Babies Article (1/student)
- Four corners posters (*See instructions in Elaborate section below)

Instructions

Engage

1. It may be useful to read the paragraphs at the top of the student guide aloud to introduce students to this pop-out.
2. Then, individually, have students read through the imaginary case about *Apoptosis* medicine.
3. Discussing the questions with a partner, have students complete the graphic organizer that follows (see below).
 - We recommend having students discuss their thoughts in partners so they can learn from each others’ perspectives. This pop-out continues the theme of discussing topics in partners or groups to encourage students to engage with a variety of ideas enmeshed in ethical dilemmas.

What are benefits of the medicine?	The medicine can help cure 82% of people with early stage lung cancer.
What are downsides of the medicine?	One ingredient in the medicine, a heavy metal, is mined from the Earth. To get the metal in the right form for the medicine, it has to be cleaned in a series of water tanks. This process pollutes the water sources and may cause illness for the communities who drink the water.
Would you make the medicine? <i>Why or why not?</i>	There is no right or wrong answer for this, however, students should present evidence for why they would or would not make the medicine. They may use the evidence from the benefits and downsides of the medicine (listed above).

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- As a class, share ideas from each facilitating question in a class-wide discussion. The use of equity sticks is encouraged for more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details). By the end of the discussion, the class should have a general understanding of the benefits and downsides of the medicine, as well as an idea of whether they would make the medicine or not.

Explore

- Provide each student with a copy of the *Unit 3, Pop-Out Zambia Article*. Students should read and annotate it individually, using a strategy that is familiar in your classroom. If you notice students are not using their annotation strategies, remind them that the strategies will help them learn the information.
- Once students complete the reading, have students answer the questions on their student guides in partners. Walk around and look at the responses students are generating.
 - Try not to provide any explicit answers, but you may point out parts of the information to focus on if students are struggling.

Possible student responses are included below:

Approximately how many people needed food in Zambia? Why?	3 million people needed food because of a series of floods and droughts.
What is genetically modified food?	Genetically modified (GM) food is food that has been changed by scientists to change traits, like adding resistance to insects or drought tolerance to crops.
There are some people who fear GM foods. Why?	People fear that there may be negative long-term effects on people and the environment. There are also various organizations that state that GM foods will result in a decrease in trades with the EU.
In Zambia, who supported taking the GM foods? Why?	The hungry villagers supported accepting the food because they needed food to eat.
Who was against taking the GM foods? Why?	The rich and powerful class supported rejecting the food because they viewed it as a display of Zambian strength.

Explain

- Students will then use the information they have gathered to write a short response to the question: *If you were the President of Zambia, would you accept the genetically modified food? Why or why not?*
 - Emphasize that students should consider the prompting questions listed in their student guide to help them consider various aspects of the dilemma. It may be helpful to highlight some of the questions if you notice students are struggling as they’re writing.
 - Remember that there is no correct answer to the student prompt; however students should provide evidence from the article to support their stance.

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2. Facilitate a class discussion in which students debate the various aspects of the Zambia food crisis. The use of equity sticks is encouraged for more equitable participation in class-wide discussions/debates like these (See “How To Use This Curriculum” for more details).
 - To jumpstart the discussion, use the questions from the student guide: *What is the problem? What is the solution? Who will be helped and hurt? What are the benefits of the solution you would choose? What is the cost of the solution you would choose? What are the short-term and long-term effects of the solution you would choose?*

Elaborate

1. This last scenario takes what they have learned and applies it to a current-day scenario that is very controversial--the ethical debate around designer babies. First, distribute the *Unit 3, Pop-Out Designer Babies Article* to each student. Working individually, students should read the article. Urge them to keep in mind what they have learned over the course of this pop-out.

2. To generate student thought about designer babies, prepare the room for a Four Corners activity.
 - Label the four corners of the room with signs that say “Strongly Agree”, “Agree”, “Disagree”, and “Strongly Disagree”.
 - Explain to students that they will be read a series of statements related to designer babies. Following each question, they move to the corner of the room that best reflects their personal opinion. They must pick one corner. They’ll need to be ready to share their thoughts aloud to the class.
 - You may come up with any statements you find interesting, but some possibilities include: *I think designing babies will decrease the number of babies who are born sick. I think designing babies might decrease crime in our country if we can eliminate genes that affect traits like anger or mental illness. I think designing babies will cause more discrimination and racism in our country. I think parents should be able to design babies only to prevent birth defects or disease. I think deaf or blind parents should be able to design babies that are also deaf or blind. I think parents should be able to design babies with any traits they want, such as hair color or eye color. I think designing babies should only be allowed if cost was not an issue, so everyone could do it. I think designing babies is unfair and should never be allowed.*
 - Read the statements aloud one at a time, allowing students time to move to their corner of choice. Calling on volunteers or using equity sticks, have a representative from each corner share their perspective after each statement.

3. Have students take a few minutes to complete the table in their student guides based on what they read in the article and what they learned during the four corners activity.
 - This will help students organize their thoughts for the Evaluate task.
 - Possible student answers are included below:

What are the reasons for designer babies?	What are the reasons against designer babies?
1. We can cure genetic diseases in embryos 2. It could decrease the rate of diabetes, heart disease, or cancer	1. It is expensive 2. It allows people to pick what their children look like, which could lead to more discrimination

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3. It allows parents to have the exact baby of their choice	3. It may lead to a population with less diversity
<p>Do you think designer babies should be allowed? Why or why not?</p> <p>There is no right or wrong answer. Encourage students to think critically about the reasons for and against designer babies and use that as evidence to support their opinion.</p>	

Evaluate

1. Since students have engaged with a variety of ethical dilemmas through the course of this pop-out, the final task presents them with the opportunity to fully consider the various ethical perspectives within one large dilemma—Genetically Modified Organisms. This allows students to tie together diverse perspectives they’ve garnered into their own argument and utilize evidence from different cases to make a larger argument.

2. At the end of the task, ask students to reflect on what they have learned over the course of this pop-out by writing a balanced account of GMOs, using both crops and babies as examples.
 - Remind students to provide evidence of both sides of the argument, their personal opinion and a conclusion statement that ties to the larger question of what is ethical in science. This will allow students to relate their ethical exploration to science in a larger, and more personal, context.
 - You may provide these sentence starters to students: *Over the last couple of days in class, we talked about...One side of the argument is that... first, second ...The other side is that... first, second...However, I believe...because...In conclusion...Deciding what is ethical in science is complex because....*
 - Remind students to cite evidence as they did when they were sharing opinions on the Zambia Food Case during the Explain.

3. There are no right answers, but encourage students to look back at their work in their student guides. They should consider what they learned from the Engage, Explore, and Elaborate. It’s okay if students do not definitively pick one side of the argument. Since these are complex, nuanced ethical dilemmas, students may offer answers that show various complex aspects of GMOs. For example, students may be pro GMOs for crops but not for people.

Assessment

1. You may collect the student guide handout and assess using:
 - *Criteria of your choice.* We recommend focusing on the conclusion paragraph from the Evaluate to assess students’ engagement around ethics.
 - This can be a formative tool to look for trends in student demonstrations of skills and practices. You can then use this formative data to inform future instruction.

Food Crisis in Zambia

Explore Article

By the early 2000s, Zambia, a nation in southern Africa, had suffered from years of severe droughts and flooding that left roughly 3 million people without access to enough food. In 2002, President Mwanawasa of Zambia refused 35,000 tons of international food aid even though many in his country were starving because he said it was harmful to his people.



The international food in question was genetically modified (GM) corn, mostly donated from the United States. Genetically modified food contains genetic material from another organism. The corn had been changed to add traits that the crop did not originally possess, like resistance to insects or tolerance to drought. Critics of GM foods say the technology is untested and the long-term effects on people and the environment are unknown. In addition, they fear that GM crops might infect a nation's other crops, causing later problems. Many critics of GM technology are in the European Union (EU), where many GM foods are prohibited or require special labeling. However, the EU issued statements saying that scientists have not found evidence of harm to humans from genetically modified foods.

The World Food Program, which distributes the food aid, said that they wouldn't force Zambia to accept the shipments. But they feared that Zambian citizens would starve or that people would riot if they did not get the corn.

Zambia rejected the genetically modified food based on reports from various organizations. Greenpeace, the Genetic Food Alert, and Farming and Livestock Concern told Zambia that the GM corn could shut down organic food trades between Zambia and the EU. They also said that there could be negative health effects, such as the GM corn causing HIV. While none of these claims were backed by scientific evidence, they were successful in convincing Zambia to reject the GM corn. While scientists continue to debate the research, many nations believe GMOs are safe.



Many international organizations such as Food First, a research and policy group, have criticized the international community for offering the GM food. They believe that it was unfair to Zambia because it put the country in a position where it either had to accept GM food or it had to refuse international assistance. They also criticize the use of GM seeds in general, saying the system forces poor farmers to rely on huge companies.

People across many different political and class lines considered the debate at the time. The wealthy population supported refusing GM foods because they viewed it as an act of Zambian strength. Starving villagers, however, generally wanted the food, but lacked the political power to accomplish this goal, according to foreign diplomats.

Sources:

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- <https://www.sciencedirect.com/science/article/pii/S030691920400065X>
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- <https://faculty.washington.edu/jhannah/geog270aut07/readings/GreenGeneRevolutions/Zerbe%20-%20GMOs%20in%20food%20aid.pdf?forcedefault=true>

Designer Babies: Creating the Perfect Child

Elaborate Article



LONDON, England (CNN) -- Bring your partner, grab a seat, pick up your baby catalog and start choosing.

Will you go for the brown hair or blond? Would you prefer tall or short? Funny or clever? Girl or boy? And do you want them to be a muscle-bound sports hero? Or a slender and intelligent bookworm?

When you're done selecting, head to the counter and it's time to start creating your new child.

Does this sound like a scary thought?

With rapid advances in scientific knowledge of the human genome and our increasing ability to modify and change genes, this scenario of "designing" your baby could well be possible in the near future.

Techniques of genetic screening are already being used -- whereby embryos can be selected by sex and checked for certain disease-bearing genes. This can lead to either the termination of a pregnancy, or if analyzed at a pre-implantation stage when using In Vitro Fertilization (IVF), can enable the pregnancy to be created using only non-disease bearing genes.

In October 2008, British scientists developed a "genetic MoT" test, which offers a universal method of screening embryos for diseases using a new technique of karyomapping, which is more efficient than previous processes.

The test would be taken on a two-day-old IVF embryo and is yet to be validated, but it could mark a significant change; allowing doctors to screen for gene combinations that create higher risks of diabetes, heart disease or cancer.

Experts estimate the test, if licensed by the Human Fertilization and Embryology Authority, could be available for around \$3000.

In the future we may also be able to "cure" genetic diseases in embryos by replacing faulty sections of DNA with healthy DNA, in a process called germ line therapy. This has been performed on animal embryos but is currently illegal for humans.

Furthermore, the developing technologies of genetic alteration open up a whole new set of possibilities -- which could result in so-called "designer babies."

The technique -- known as inheritable genetic modification -- modifies genes in eggs, sperm or early embryos and results in the altered genes being passed on to future generations. Should parents be allowed to create their babies?

This could potentially irreversibly alter the human species. So, the obvious question arises: should we be doing this?

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Pop-Out Essential Question: *How do we contribute to environmental problems and how do these problems affect certain populations more than others?*

Introduction

In this pop-out, students use their understanding of how humans impact the environment from Units 3 and 4 to examine how human behaviors (even theirs!) contribute to environmental injustice. Students will explore a variety of cases across the globe to expand their views of different environmental problems and which communities are affected by these problems. Students then hone in on one case study that showcases a community effecting change through activism, so they might examine strategies to combat the injustice. Finally, students will reflect on how and why certain communities are disproportionately affected by environmental problems and consider their role in those problems. Throughout this pop-out, students are engaging with concepts of cause and effect, considering the relationship between people and the environment, and honing problem-solving skills.

We recommend engaging with this pop-out after you have completed Task 2 of Unit 4. Because the pop-out highlights cases of environmental injustice around the world, it is helpful for students to have a sense of how humans interact with their environment prior to the pop-out.

Alignment Table

<p>Content</p> <ul style="list-style-type: none"> ● Environmental injustice is when minority communities are unfairly affected by the impacts of environmental problems. ● Considering environmental injustice is an important component of exploring the relationship between people and the environment. ● Individual’s actions affect many global environmental problems through cause-and-effect relationships.
<p>Understandings about the Nature of Science (from NGSS Appendix H)</p> <ul style="list-style-type: none"> ● Science depends on evaluating proposed explanations. ● Science knowledge is based upon logical and conceptual connections between evidence and explanations. ● Scientific findings are frequently revised and/or reinterpreted based on new evidence. ● Science is a way of knowing used by many people, not just scientists. ● Scientists’ knowledge can describe consequences of actions but is not responsible for society’s decisions.
<p>Science, Technology, Society, and the Environment (from NGSS Appendix J)</p> <ul style="list-style-type: none"> ● Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. ● All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. ● The uses of technologies are driven by people’s needs, desires, and values, by the findings of scientific research, and by differences in such factors as climate, natural resources, and economic conditions. ● Technology use varies over time and from region to region.
<p>Equity and Group work</p> <ul style="list-style-type: none"> ● Work together to analyze, evaluate, and interpret information.

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- Co-construct a poster to share information.
- Discuss with peers to learn about other perspectives regarding charged situations and the individual's role in them.

Language

- Use annotation strategies to dissect text.
- Communicate ideas verbally in class discussions.
- Gather information from written, spoken, or video format.
- Communicate a complex situation in a poster.

Learning Goals

This pop-out asks students to explore their connections to environmental problems and question why these environmental problems disproportionately affect specific communities. More specifically, the purpose is to:

- Engage students' through a flow chart quiz connecting their behaviors to large environmental problems.
- Analyze a case study to understand the complex context of an environmental problem.
- Make a poster to communicate information and learn from other students' cases through a gallery walk.
- Examine a case of an environmental problem that a community changed.
- Evaluate the context of environmental injustice: What are the commonalities between communities affected and how are student actions contributing to the proliferation of environmental injustice?

Content Background for Teachers

Environmental problems are disproportionately located in low socioeconomic areas and correlated to racial divides. This concept, called Environmental Injustice, is demonstrated in a variety of cases around the world (see student materials for additional information on specific examples). In this pop-out, students will use their understanding from Units 3 and 4 of how humans impact the environment to examine how human behaviors (even theirs!) affect environmental injustice.

Academic Vocabulary

- Environmental injustice
- Environmental racism
- Disproportionate
- Socio-economic
- Other words present in case studies that are not relevant to main outcomes, but may be useful for student understanding (Glyphosate, hexavalent chromium, chloroprene, Apartheid, uranium, etc.)

Time Needed (Based on 45-Minute Periods)

3 Days

- Engage: 0.5 class
- Explore: 0.5 class
- Explain: 1 class
- Elaborate: 0.5 class
- Evaluate and Reflection: 0.5 class

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Materials

- Unit 4, Pop-Out Student Version

Explore

- Pop-Out Case Studies 1-6 (1/student by group)
- Computers and/or headphones (by group)

Explain

- Poster materials - posters and markers (1/group)
- Tape for gallery walk

Elaborate

- Unit 4, Pop-Out Soybean Pesticide Case Study (1/student)

Instructions

Engage

1. You may want to introduce the pop-out by reading the student guide introduction and Engage instructions aloud.
 - The purpose of this activity is to allow students to see how their lifestyle and environment may be connected to environmental problems across the globe. Emphasize that they are not alone in their actions, and we are learning about how our actions impact the Earth so we can make educated decisions in the future.
2. Bring students together to facilitate a class-wide discussion in response to the flowchart. The use of equity sticks is encouraged for more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details). A question to jump start the discussion is: What environmental problem did you contribute to? Do you think there are other ways you contribute to the problem? Look back at your flowchart. Are there other environmental problems your actions contribute to aside from the one you landed on?
 - By the end of the discussion, the class should have discussed how their own actions impact environmental problems.

Explore

1. Provide each group with a case study reading (1/student). There are six case studies in total comprised of videos, podcasts, articles and/or websites. Some student groups will need a computer and headphones (case study 2, 3, 5, 6).
2. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Recorder, and Harmonizer.
 - Ask the Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to handle any resources (e.g. computers, headphones, case studies) needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.

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- Ask the Recorder to make sure the group is taking notes and collecting evidence from their case study.
- 3. Ask students to use an annotation strategy (whatever you use in your classroom regularly) to read and analyze their case study as a group.
- 4. Using their student guides, students should fill out the graphic organizer chart for their case study, making sure to provide detailed answers. They will use their case study to make a poster for a gallery walk later in the pop-out.

Possible answers for each case study are included below:

Case Number and Location	1 – Hinkley, California
Describe the context where the environmental problem takes place: <ul style="list-style-type: none"> ● <i>Where is the problem?</i> ● <i>What is relevant information about the population living in that area (size, income levels, racial breakdown)?</i> 	The problem is in a small town in southern California, called Hinkley. Hinkley is a community of less than 2000 people. At the time of the pollution, over 20% of the population was living on an income of less than \$15,000/year and had a lower college graduation rate than the rest of California.
Describe the environmental problem: <ul style="list-style-type: none"> ● <i>What is the problem?</i> ● <i>What are the impacts on the environment?</i> 	Pacific Gas and Electric (PG&E) knowingly polluted the community’s groundwater with very high levels of Hexavalent Chromium (a bad water pollutant). The water sources remain polluted by high levels of hexavalent chromium today.
Describe the people involved: <ul style="list-style-type: none"> ● <i>Who benefits from the situation and why?</i> ● <i>Who suffers most of the consequences and why?</i> 	PG&E benefited from polluting the water, because they were able to continue using the facility that leaked hexavalent chromium into the water. That allowed them to keep running their business at a fast pace. The population of Hinkley, CA suffered from the water pollution as seen through increased cancer and illness rates for those in the community.
Reflect on the case study: <ul style="list-style-type: none"> ● <i>How does this make you feel?</i> ● <i>Do you think this is fair or not? Why?</i> 	There are no right or wrong student answers in this section, so long as students appropriately explain their feelings and thoughts using relevant examples from the case study.

Case Number and Location	2 – Cancer Alley, Louisiana
Describe the context where the environmental problem	

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<p>takes place:</p> <ul style="list-style-type: none"> • <i>Where is the problem?</i> • <i>What is relevant information about the population living in that area (size, income levels, racial breakdown)?</i> 	<p>The problem is located in the area between New Orleans and Baton Rouge in Louisiana.</p> <p>The population is mostly low-income and black. The area has an unusually high unemployment rate and a low college graduation rate.</p>
<p>Describe the environmental problem:</p> <ul style="list-style-type: none"> • <i>What is the problem?</i> • <i>What are the impacts on the environment?</i> 	<p>The problem is that there are significant amounts of air pollution from a number of factories (namely one plant that makes rubber and emits chloroprene into the air).</p> <p>The air is full of pollution. This pollution also affects the water system.</p>
<p>Describe the people involved:</p> <ul style="list-style-type: none"> • <i>Who benefits from the situation and why?</i> • <i>Who suffers most of the consequences and why?</i> 	<p>The owners of the Du Pont/Denka plant (and other factories) benefit. They are able to make the products that produce air pollution.</p> <p>The population living in the area suffers from many health problems as a result of the air pollution. In fact, they have the highest risk in the nation of developing cancer from air toxins (between 5 and 20 times that of the national average).</p>
<p>Reflect on the case study:</p> <ul style="list-style-type: none"> • <i>How does this make you feel?</i> • <i>Do you think this is fair or not? Why?</i> 	<p>There are no right or wrong student answers in this section, so long as students appropriately explain their feelings and thoughts using relevant examples from the case study.</p>

Case Number and Location	3 - Cape Town, South Africa
<p>Describe the context where the environmental problem takes place:</p> <ul style="list-style-type: none"> • <i>Where is the problem?</i> • <i>What is relevant information about the population living in that area (size, income levels, racial breakdown)?</i> 	<p>The problem is in Cape Town, South Africa.</p> <p>The water crisis affects everyone, however, some people are able to pay to have a private water drill installed on their land. This allows wealthy people to access their own water whereas less wealthy people do not have access to water aside from public taps. The divide between rich and poor is historically associated with skin color.</p>
<p>Describe the environmental problem:</p> <ul style="list-style-type: none"> • <i>What is the problem?</i> • <i>What are the impacts</i> 	<p>The problem is that there is a severe lack of drinking water in Cape Town. Due to droughts and floods over the last few years, there is not enough water for the Cape Town community to use unregulated.</p> <p>The environment is impacted by droughts and floods. Many scientists believe</p>

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<i>on the environment?</i>	that climate change is the root cause of these droughts and floods.
Describe the people involved: <ul style="list-style-type: none"> • <i>Who benefits from the situation and why?</i> • <i>Who suffers most of the consequences and why?</i> 	Drilling companies and wealthy people benefit from the drilling of private wells. Anyone in the community who cannot afford their own water drill suffers. Because there is a limited amount of water for the entire Cape Town population, if some people (with drills) are using more water, there is less for everyone else.
Reflect on the case study: <ul style="list-style-type: none"> • <i>How does this make you feel?</i> • <i>Do you think this is fair or not? Why?</i> 	There are no right or wrong student answers in this section, so long as students appropriately explain their feelings and thoughts using relevant examples from the case study.

Case Number and Location	4 - Washington, D.C.
Describe the context where the environmental problem takes place: <ul style="list-style-type: none"> • <i>Where is the problem?</i> • <i>What is relevant information about the population living in that area (size, income levels, racial breakdown)?</i> 	<p>The problem is in Washington, D.C.</p> <p>The communities affected are mostly low-income and people of color.</p>
Describe the environmental problem: <ul style="list-style-type: none"> • <i>What is the problem?</i> • <i>What are the impacts on the environment?</i> 	<p>The problem is that trash centers are concentrated in specific parts of Washington, D.C.</p> <p>The waste process (e.g. landfills, transfer stations) increases odors, animal infestations, air pollution from vehicles and chemicals in the trash.</p>
Describe the people involved: <ul style="list-style-type: none"> • <i>Who benefits from the situation and why?</i> • <i>Who suffers most of the consequences and why?</i> 	<p>The affluent people living in communities without landfills and transfer stations benefit from the situation because they can create waste and not have to live with the consequences.</p> <p>The people living in the affected communities (mostly low income and people of color) suffer from the situation. They are subject to increased disease and pollution rates.</p>
Reflect on the case study: <ul style="list-style-type: none"> • <i>How does this make you feel?</i> • <i>Do you think this is fair or not? Why?</i> 	There are no right or wrong student answers in this section, so long as students appropriately explain their feelings and thoughts using relevant examples from the case study.

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Case Number and Location	5 - Guiyu, China
Describe the context where the environmental problem takes place: <ul style="list-style-type: none"> • <i>Where is the problem?</i> • <i>What is relevant information about the population living in that area (size, income levels, racial breakdown)?</i> 	<p>The problem is in small communities, like Guiyu, in China.</p> <p>The communities affected often have low income and low education levels compared to the rest of China.</p>
Describe the environmental problem: <ul style="list-style-type: none"> • <i>What is the problem?</i> • <i>What are the impacts on the environment?</i> 	<p>When recycling is done poorly, as seen in Guiyu, it is devastating for the local environment.</p> <p>There are piles of waste across the land, and chemicals from that waste can pollute the water sources in the area. The polluted water is used for growing crops, therein increasing pollution in foods. Piles of trash change the landscape for animals in the area. Burning plastics creates air pollution.</p>
Describe the people involved: <ul style="list-style-type: none"> • <i>Who benefits from the situation and why?</i> • <i>Who suffers most of the consequences and why?</i> 	<p>The people who work at or own the recycling factories benefit from the situation. It is also important to note that the worldwide electronics consumers benefit from the situation because they are able to use electronics and not have to suffer the consequences of recycling electronics.</p> <p>The workers and the community members in Guiyu suffer most of the consequences because their lands are polluted by waste and they are affected by the health impacts.</p>
Reflect on the case study: <ul style="list-style-type: none"> • <i>How does this make you feel?</i> • <i>Do you think this is fair or not? Why?</i> 	<p>There are no right or wrong student answers in this section, so long as students appropriately explain their feelings and thoughts using relevant examples from the case study.</p>

Case Number and Location	6 - Navajo Nation
Describe the context where the environmental problem takes place: <ul style="list-style-type: none"> • <i>Where is the problem?</i> • <i>What is relevant information about the population living in that area (size, income levels, racial breakdown)?</i> 	<p>The problem is on the Navajo Nation in the southwest United States.</p> <p>The Navajo people are affected by the problem and over 95% of those people live below the poverty line.</p>

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<p>Describe the environmental problem:</p> <ul style="list-style-type: none"> • <i>What is the problem?</i> • <i>What are the impacts on the environment?</i> 	<p>The problem is that Uranium mines polluted nearby lands (water sources and land) and continue to do so.</p> <p>The pollution created by Uranium mining harms the landscape. The water pollution affects plants, animals, and people in the area around the mine.</p>
<p>Describe the people involved:</p> <ul style="list-style-type: none"> • <i>Who benefits from the situation and why?</i> • <i>Who suffers most of the consequences and why?</i> 	<p>The beneficiaries include the mine owners and the United States government (who wanted Uranium for commercial and defense purposes).</p> <p>The Navajo people suffer the brunt of the consequences. Miners experienced very high rates of lung cancer. Navajo people living close to the mines had to live with water pollution, high illness rates, and a changing environment.</p>
<p>Reflect on the case study:</p> <ul style="list-style-type: none"> • <i>How does this make you feel?</i> • <i>Do you think this is fair or not? Why?</i> 	<p>There are no right or wrong student answers in this section, so long as students appropriately explain their feelings and thoughts using relevant examples from the case study.</p>

Explain

1. Now that students have learned about one environmental problem, they can begin to explore how their case is not an isolated one. Environmental injustice is a trend seen across many different environmental problems. Students will engage with six environmental injustice cases and continue to develop a broad conceptualization of how environmental injustice affects different communities globally.
2. Working in their groups, students will prepare a poster about their case. The purpose of this poster is to clearly convey all relevant information from their case study for other students to learn. Encourage students to use both their case study and notes recorded in the graphic organizer as they create their poster. Remind students to use visual aids (visuals, flow charts, diagrams) to enhance their poster.
3. Provide groups with presentation materials and assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Reporter, and Harmonizer. It may be useful to assign roles that differ from the roles students held in the Explore.
 - Ask the Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to handle any resources needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Reporter to make sure the group is making a strong poster of their case study.
4. Once groups have had sufficient time to make their posters, have each group tape their poster on the perimeter of the classroom in preparation for the gallery walk.
 - Provide instructions for how to engage with a gallery walk. Emphasize to students that as they walk around the room, they need to thoroughly read through each poster on the wall. They can

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take notes on each of the posters using the space provided in their student guides. By the end of the gallery walk time, students should have a good sense of each of the case studies.

- You may want to circulate during the gallery walk to ensure that students are on task and engaging with the material. If needed, remind students that their understanding of the cases will help them with the final portion of this pop-out.

Elaborate

1. Students have seen a variety of Environmental Injustice cases. While the scope of the problem is daunting, there are many steps communities and individuals can take to improve their situations! This section of the pop-out asks students to apply what they have learned about environmental problems in the world to a specific case with a different, more hopeful outcome.
2. In groups, have students read through the *Unit 4, Pop-Out Soybean Pesticide Case Study*. You may use a smartboard, projector, or handouts for students to engage with the reading.
 - The case study is comprised of three different excerpts from articles. They provide the context of how pesticides used for soybean production in Argentina are affecting communities. The excerpts also showcase the ways in which communities and individuals have sought to change the environmental problem. By the end of the reading, it is important for students to hone in on the strategies that people utilized to alter the environmental problem.
3. While reading, students should record relevant thoughts in the graphic organizer below. This graphic organizer provides them with the tools they need to engage in the final portion of this pop-out. Possible answers are included in the table below:

Describe the situation:

What were the big companies doing and why?

Argentina is currently the third-largest soybean producer in the world. Big companies, including Monsanto (a biotechnology company from the United States) began growing soybeans in parts of Argentina. The companies use pesticides to increase the soybean production. The pesticides are regularly sprayed in very close proximity to schools and communities.

How did this affect the community?

The community is largely affected by high cancer and illness rates (41 times the national average). This is likely caused by exposure to Glyphosate, a key ingredient in the pesticide spraying.

What did the community want to change?

Many within the community wanted their communities to be safe, clean places for people to live. To make this happen, some community members wanted soybean producers to stop spraying close to schools and communities, to stop spraying so much, and to decrease soybean production.

What human actions contributed to changing the situation?

A group of women from an affected community filed lawsuits against the soybean producers. Various citizens also protested the building and using of a soybean plant. Their organized civil disobedience consisted of protests, forming a blockade, and filing lawsuits.

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Evaluate

1. The final section of the pop-out provides students with the opportunity to tie together their learnings into a conceptual understanding of environmental injustice and to also consider what agency they have.
2. Provide students with time to work individually on answering the reflection questions in their student guides.
3. In groups, have students discuss their reflection questions. Remind students that they will conclude in a class-wide discussion.
4. As a whole class, discuss the reflection questions. Briefly address class behavior norms for discussions. You may use any of the questions from the student guide as a jump-off point: *What do the different case studies have in common? Why do certain communities seem to be more affected by environmental problems than others? Regardless of whether your community is personally affected, we all are connected to these environmental problems: How are you personally contributing to these environmental problems? What can you do about it?*

Assessment

1. You may collect the student guide handout and assess using:
 - *Criteria of your choice.* We recommend focusing on the content of the posters in the Gallery Walk to understand how students explain cause-and-effect relationships between human activity and environmental issues.
 - This can be a formative tool to look for trends in student demonstrations of skills and practices. You can then use this formative data to inform future instruction.

Hinkley, California

Explore Case Study 1

1. Background Information:

Hinkley, CA is a small town, of just 1,900 people, located in the Mojave Desert in Southern California. Pacific Gas and Electric (PG&E) built a facility near Hinkley in the 1950s that leaked Hexavalent Chromium (a very harmful type of water pollution) into the groundwater for over 30 years before anyone in the community realized it. Hinkley had a lower college graduation rate than the rest of California and about 20% of the Hinkley population was living off of less than \$15,000/year. Because the community was so small, it was possible for PG&E to continue polluting the community's water source without consequence. According to the California Water Resources Control Board documents, the water clean-up began in the late 1980s and continues today.

2. Read the article:

Hexavalent Chromium: One Town's Story

On 7 December 1987, officials from Pacific Gas and Electric Company (PG&E), the world's largest utility, advised California regulatory authorities that they'd detected hexavalent chromium (Cr[VI]) at levels of 580 micrograms per liter ($\mu\text{g/L}$)—over 10 times the state's 50- $\mu\text{g/L}$ limit for total chromium in a groundwater monitoring well. Cr(VI) was being used as an anticorrosive in the cooling towers of a PG&E gas compressor station in the Mojave Desert town of Hinkley.

People who lived in Hinkley had experienced a disturbing array of health problems: liver, heart, respiratory, and reproductive failure, cancer of the brain, kidney, breast, uterus, and gastrointestinal system, Hodgkin disease, frequent miscarriages, and more. Were these problems related to the compressor station's wastewater ponds? PG&E officials said no. But until 1972, PG&E had knowingly released 370 million gallons of Cr(VI)-contaminated wastewater into the unlined ponds, and the toxic compound had made its way into Hinkley's groundwater.

In 1993, 77 Hinkley plaintiffs filed a lawsuit against PG&E. The suit was a direct result of a massive communications effort mounted by Erin Brockovich, an employee in a local law firm. She had uncovered the utility's environmental misconduct and launched a personal investi-

gation that ended in the largest settlement on record for a civil class-action lawsuit. PG&E filed a motion to strike all claims for preconception injuries (fear of cancer) as speculative. But the plaintiffs—648 by the end—ended up recovering for injury claims and settling with PG&E for \$333 million. In addition, PG&E agreed to stop using Cr(VI) and clean up the contamination.

The case remains controversial among chromium experts because most of the Hinkley exposures involved drinking Cr(VI)-laced water. This route of exposure is widely believed to cause much less toxicity than inhalational exposures because ingested Cr(VI) is converted to inactive trivalent chromium in the stomach. Many experts also claim that the exposures were too low to cause health effects, and that there are few data linking Cr(VI) exposures to the Hinkley residents' symptoms. But others counter that there are too many gaps in the data on chromium to dismiss the Hinkley residents' case. They believe the fact that this toxic form of chromium can enter all types of cells means that scientists may yet

discover that it can damage many organ systems. Until more is known about how different doses and routes of exposure of Cr(VI) affect different populations, it is too soon to rule out high drinking water exposures as a health risk.



Chromium hits the silver screen. Actress Julia Roberts played the title character in *Erin Brockovich*, a film based on the Hinkley case.

Sources:

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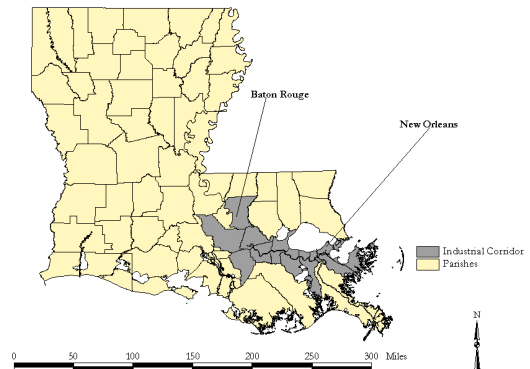
Cancer Alley, Louisiana

Explore Case Study 2

1. Background information:

Cancer Alley is the area between New Orleans and Baton Rouge in Louisiana (see the map for more information). The population living in the area is predominantly black and low-income. Although there are over 136 industrial factories, unemployment is high in the area. Most residents do not have a college education.

Louisiana's Industrial Corridor



2. Watch video found on CNN:

<https://www.cnn.com/2017/10/20/health/louisiana-toxic-town/index.html>

Sources:

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Cape Town, South Africa*Explore Case Study 3*

1. Additional Information:

South Africa is comprised of: 42.4% "Colored*", 38.6% "Black African", 15.7% "White", 1.4% "Asian or Indian", 1.9% other. *The racial category "colored" is very controversial. It is a term left over from the Apartheid (South African policies of segregation based on race) that lumps together any race or ethnicity that does not fit into one of nine tribes recognized in South Africa. The "colored" population is largely descended from slaves in the 17th century and the current population is concentrated in the Western part of the country. South Africa was segregated by race for many years. This led to people of a certain race holding most of the wealth and power within the country. In South Africa today, there is a strong link between race and socioeconomic status; white citizens are more likely to be wealthy than colored, black, Asian or Indian citizens.

2. Watch the video on National Geographic: <https://video.nationalgeographic.com/video/news/how-cape-towns-residents-are-surviving-the-water-crisis-for-now?source=relatedvideo>
3. Listen to the podcast on National Public Radio: <https://www.npr.org/2018/03/25/596880493/cape-town-s-water-crisis-marks-divide-between-rich-and-poor>

Sources:

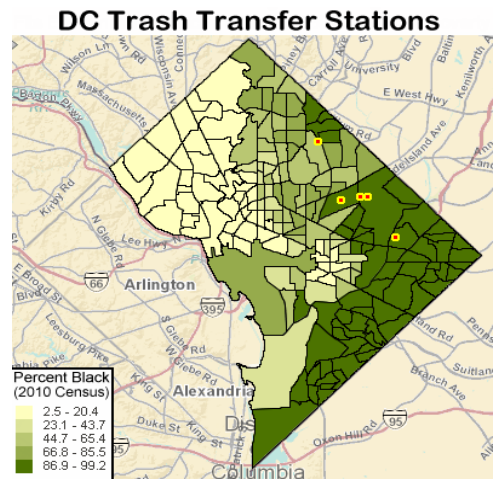
- <https://www.npr.org/2018/03/25/596880493/cape-town-s-water-crisis-marks-divide-between-rich-and-poor>
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- <http://worldpopulationreview.com/world-cities/cape-town-population/>

Washington, D.C.
Explore Case Study 4

1. Read the excerpt from an article:

Few in our nation's capitol city think twice when they throw stuff "away" -- nor do they think about who lives where "away" is. Fitting a national trend of environmental racism, it should be no surprise that DC's waste has long impacted communities of color in one of the most segregated metropolitan areas in the country. (Black-white racial segregation in the Washington, DC area is considered "extreme" and is 17th worst in the nation.)

Transfer stations, from west to east, include: Fort Totten, Federal IPC, Rodgers Brothers, WMI Northeast and Benning Road. Before waste actually goes for disposal, much goes to a transfer station first. Transfer stations exist to move waste from small collection trucks into big trucks for longer-distance hauling. In 2000, the EPA's National Environmental Justice Advisory Council noted that waste transfer stations "are disproportionately clustered in low-income communities and communities of color."



DC's Department of Public Works (DPW) runs two large transfer stations, in black communities at Fort Totten and Benning Road. These transfer stations are large enough to take care of the city's needs, but [many] private transfer stations cropped up years ago, in the absence of regulations. Of about 15 that opened, many have since been closed (after much struggle), and some are still being demolished, yet three remain -- all clustered in Ward 5, in the adjacent black residential neighborhoods of Brentwood and Langdon. Residents of these neighborhoods have been struggling to close these private transfer stations for three decades. They spoke passionately about their experiences at a Feb 5th, 2014 DC City Council hearing where Ward 5 Councilman McDuffie was joined by other members of council in pushing a bill to increase enforcement on these facilities. In addition to nuisances like odors, "vectors" (seagulls, rats), and trucks (and their diesel exhaust), transfer stations are also a source of airborne mercury pollution from sources such as broken fluorescent bulbs.



2. Additional Information: This phenomenon is also true in the Democratic Republic of Congo (a country in central Africa), where waste (trash) ends up in poorer areas much more than in wealthy areas.

Sources:

- <https://www.tandfonline.com/doi/abs/10.1080/13549839.2015.1038985>
- <https://www.tandfonline.com/doi/full/10.1080/13549839.2016.1242120?src=recsys>
- [https://fthmb.tqn.com/Q8RbYMVpBaIne7CVLn96ErvGaOI=/768x0/filters:no_upscale\(\):max_bytes\(1500\):strip_icc\(\):format\(webp\)/1084px-Democratic_Republic_of_the_Congo_in_Africa.svg-588fc6713df78caebc3e1394.png](https://fthmb.tqn.com/Q8RbYMVpBaIne7CVLn96ErvGaOI=/768x0/filters:no_upscale():max_bytes(1500):strip_icc():format(webp)/1084px-Democratic_Republic_of_the_Congo_in_Africa.svg-588fc6713df78caebc3e1394.png)
- <http://www.energyjustice.net/content/dcs-waste-and-environmental-racism>

Guiyu, China
Explore Case Study 5

1. Background information:

Most of the world's electronics are assembled in China, shipped to other countries for use, and returned to China as trash or recycling. The trash and recycling centers process toxic parts of electronics. These centers are often located in low income and low education communities in China. Guiyu, China is an example of this.

2. Watch the video from CNN on: <https://www.cnn.com/2013/05/30/world/asia/china-electronic-waste-e-waste/index.html>

3. Read this part of an article from the website above:

Much of the toxic pollution comes from burning circuit boards, plastic and copper wires, or washing them with hydrochloric acid to recover valuable metals like copper and steel. In doing so, workshops contaminate workers and the environment with toxic heavy metals like lead, beryllium and cadmium, while also releasing hydrocarbon ashes into the air, water and soil, the report said.

For first-time visitors to Guiyu, the air leaves a burning sensation in the eyes and nostrils.

Studies by the Shantou University Medical College revealed that many children tested in Guiyu had higher than average levels of lead in their blood, which can stunt the development of the brain and central nervous system.

Piles of technological scrap had been dumped in a muddy field just outside of town. There, water buffalo grazed and soaked themselves in ponds surrounded by piles of electronic components with labels like Hewlett-Packard, IBM, Epson and Dell.

The enormous animals casually stomped through mounds of sheet glass, which clearly had been removed from video monitors.

Sources:

- o <https://www.cnn.com/2013/05/30/world/asia/china-electronic-waste-e-waste/index.html>

Navajo Nation

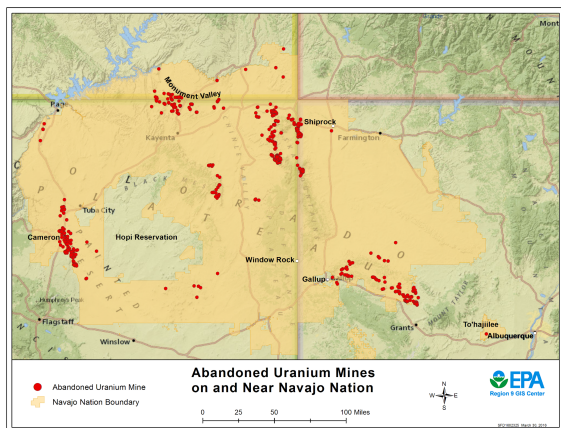
Explore Case Study 6

1. Background Information:

The Navajo Nation is a sovereign (independently run) nation of the Navajo tribe in the southwestern United States (see the maps for more information). Over 95% of people on the Navajo Nation have indigenous heritage. The average per household income is about \$20,000/year (well below the poverty line).

Uranium mining started on the Navajo Nation after WWII when the United States

needed more Uranium. Uranium is used for commercial purposes (e.g. dyes) and for military defense purposes (e.g. developing atomic bombs). Large amounts of Uranium were found in the southwest, so the United States



government and independent business owners developed mines on the Navajo Nation. Despite the known link between uranium mining and lung cancer and other illnesses, Navajo people were recruited to work in the mines and most Navajo people were not warned about the risks. Because this was one of only a few job opportunities for Navajo people living in the area, many took the jobs. Many of these miners suffered from lung cancer because of their work. Uranium affected the lives of the workers, polluted water sources for communities, and left lingering effects for many Navajo people. To this day, many of the Uranium mines have not been cleaned up (see the map for locations of abandoned mines).

2. Listen to the podcast on National Public Radio: <https://www.npr.org/sections/health-shots/2016/04/10/473547227/for-the-navajo-nation-uranium-minings-deadly-legacy-lingers>

Sources:

- <https://www.epa.gov/navajo-nation-uranium-cleanup>
- <https://www.npr.org/sections/health-shots/2016/04/10/473547227/for-the-navajo-nation-uranium-minings-deadly-legacy-lingers>
- <http://www.nec.navajo-nsn.gov/Portals/0/Reports/NN2010PopulationProfile.pdf?forcedefault=true>
- <http://navajobusiness.com/fastFacts/demographics.htm>
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Soybean Pesticides in Argentina

Elaborate Case Study

Article 1 - Argentina: The Country That Monsanto Poisoned

2012 - American biotechnology (technology related to living things) has turned Argentina into the world's third-largest soybean producer, but the chemicals powering the boom aren't confined to soy and cotton and corn fields. They routinely contaminate homes and classrooms and drinking water. A growing chorus of doctors and scientists is warning that their uncontrolled use could be responsible for the increasing number of health problems turning up in hospitals across the South American nation. In the heart of Argentina's soybean business, house-to-house surveys of 65,000 people in farming communities found cancer rates two to four times higher than the national average, as well as higher rates of hypothyroidism and chronic respiratory illnesses. Associated Press photographer Natacha Pisarenko spent months documenting the issue in farming communities across Argentina.

Most provinces in Argentina forbid spraying pesticides and other agrochemicals next to homes and schools, with bans ranging in distance from 50 meters to as much as several kilometers from populated areas. The Associated Press found many cases of soybeans planted only a few feet from homes and schools, and of chemicals mixed and loaded onto tractors inside residential neighborhoods. In the last 20 years, agrochemical spraying has increased eightfold in Argentina—from 9 million gallons in 1990 to 84 million gallons today. Glyphosate, the key ingredient in Monsanto's Round Up products, is used roughly eight to ten times more per acre than in the United States. Yet Argentina doesn't apply national standards for farm chemicals, leaving rule-making to the provinces and enforcement to the municipalities. The result is a hodgepodge of widely ignored regulations that leave people dangerously exposed.

via denverpost.com

Article 2 - Activists in Argentina Expect Landmark Ruling against Agrochemicals

BUENOS AIRES, Aug 17 2012 (IPS) - After more than a decade of campaigning against toxic agrochemicals, a group of women from a poor neighbourhood in the northern Argentine city of Córdoba have brought large-scale soybean growers to trial for the health damages caused by spraying.



The trial began in June, and the sentence is to be handed down on Aug. 21. In the dock are two soybean producers, Francisco Parra and Jorge Gabrielli, and the pilot of a spray plane, Edgardo Pancello. The prosecutors are seeking four years of prison for Parra and three years for Pancello. But the prosecutor's office has not filed

charges against Gabrielli, due to the lack of clear evidence of his responsibility, and he is expected to be acquitted. The court must decide whether there is enough evidence to link the spraying of agrochemicals with harmful health effects, and sentence accordingly.

“We are not satisfied with the sentences sought by the prosecutor. They have done so much damage to us, and we were hoping for more. But at least it will set a precedent in the country,” one of the plaintiffs, Sofía Gatica, told IPS.

Gatica won the prestigious Goldman Environmental Prize this year for her activity in defense of the environment and the lives of people in her working-class neighbourhood, Ituzaingó Anexo, on the outskirts of Córdoba.

For years, the 5,000 people of Ituzaingó Anexo suffered the impacts of spraying on the commercial soybean fields surrounding the neighbourhood. Many homes are just metres away from the crops.

In 1999, Gatica’s daughter died of kidney failure three days after her birth. The mother’s grief turned into anger, and she started to keep track of the cases of cancer, birth defects and other health problems in the neighbourhood.

She suspected that the numerous health problems were caused by glyphosate, the herbicide used on fields of genetically modified soybeans, sprayed by hand or from planes.

Gatica’s list included cases of newborns with six fingers or without a thumb, with deformed jawbones, or without intestines. “We had malformations, cancer, lupus, purpura, hemolytic anemia,” she said.

The Mothers of Ituzaingó, the name of the group of women who began to draw attention to the suspected link between the herbicide and the health problems in their community, had blood samples from local children tested, and carried out tests of the water, air and soil.

The results of the testing pointed to a link between exposure to glyphosate and health problems.

The women discovered that the cancer rate in the community was 41 times the national average. Rates of respiratory diseases, neurological problems, and infant mortality were also far higher than average.

As a result of their activism, they won a municipal ordinance banning spraying by hand within 500 metres of the neighbourhood, and aerial spraying within 2,500 metres, which created a buffer zone around the community.

Article 3 - Monsanto to Tear Down GMO Seed Plant in Argentina

2016- Monsanto have announced that they will dismantle their half-built multi-million dollar GMO seed plant in Malvinas, Argentina, following protests from local citizens over the past 3 years.

Local Malvinas citizens and GMO-Free campaigners from across Argentina forced Monsanto to stop the construction of their GMO seed plant in 2014, through well-coordinated protests at the construction site.



Sources from the head office of Monsanto in Latin America told local Argentinian media that the decision has been made to dismantle (break-down) the controversial seed plant.

The Monsanto spokesman also conceded (admitted) that the local pressure and blockade of the construction site by Malvinas residents and environmentalists had been a factor in the company's decision.

Several lawsuits have been filed against Monsanto over the illegality of the Malvinas construction permit and the environmental impacts of the project. These lawsuits are ongoing.

Sofia Gatica, one of the leaders of the blockade in Malvinas, told Inf'OGM that "It's been almost three years that Monsanto has not been able to put a brick or a wire at the construction site... The company is leaving the field but does not yet recognize its defeat in this battle. We talked with those who have to dismantle what remains. We remain on alert and continue blocking, waiting to see what will happen. We want the site to now be devoted to organic and sustainable agriculture."

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