Structured Academic Controversy:
The U.S. Should Not Use Nuclear Energy as a Main Source of Energy to Reduce Carbon Emissions

Essential Question:
What is our ethical responsibility as scientists when examining the nature of nuclear energy?

Overview:
This structured academic controversy lesson is designed to teach students to critically engage with the debate about which energy sources are the most sustainable, safest, and do the least harm to the environment. This lesson is embedded within our ongoing climate change and climate justice unit. Prior to this lesson students will have gained background knowledge about the carbon cycle, fossil fuel extraction, and the greenhouse effect. Students will have also had the opportunity to engage in learning the basic science behind nuclear energy through models and videos.

Students will begin the lesson by watching two videos that introduce the debate about the safety and sustainability of nuclear energy. They will use a note catcher to document their beginning understandings. Then they will be divided into groups of four with two students presenting arguments for the side in favor of using nuclear energy to reduce carbon emissions and two students presenting arguments for the side against using nuclear energy. Students in each group will be presented with evidence to support their claims/arguments, with scaffolded guidance to help students develop these claims. Evidence resources for the anti-nuclear energy side will include arguments for other sustainable energy sources, resources that explain how mining for uranium impacts the environment and people, and evidence about the devastating impact of nuclear power plant disasters. Evidence resources that support the use of nuclear energy will include data sets about low carbon emissions from nuclear energy compared to fossil fuels, and resources about new innovations in safety. Each side will be given time to present while the other side listens quietly. Then the side that listened will have an opportunity to ask clarifying questions. The arguing and listening roles will then be reversed and the process repeated. After the initial round of exchanges students will switch positions on the issue and have to present arguments for the side opposite of which they initially argued. The presentation and listening process is repeated. Finally, the whole class comes together for a final discussion and consensus building.

Objectives:

1) Students will be able to explain the science behind nuclear energy.
2) Students will be able to describe the environmental and human impact of nuclear energy.
3) Students will be able to raise questions about the proliferation of nuclear energy as a sustainable energy source over other sustainable sources.
4) Students will be able to develop discourse about this controversial issue by participating in group discussion and coming to consensus during the course of the lesson, with a goal towards making possible policy recommendations for energy sourcing.

Assessment:
Students will demonstrate understanding of the issue by developing evidence-based arguments for and against the use of nuclear energy as a sustainable and safe energy source. Students will be assessed on their analysis and synthesis of all sources in order to create their evidence-based arguments.

Content and Instructional Strategies:

Day 1:

1) **Hook / Controversy Background**

Students will conduct a gallery walk of data, infographics, and a short video of a debate about nuclear energy usage. This activity will support students in reviewing key ideas about how nuclear energy works as well as plant the seeds for the "pros and cons" of nuclear energy.

2) **Reading and Analyzing Resources**

Students will be divided into groups of four and asked to evaluate the excerpts provided under 3-4 "subclaims" that either support or refute the sustainability and safety of nuclear energy. Students will record their thinking in a graphic organizer. As an extension, students will connect their analysis to unit concepts of *interconnectedness, power,* and *responsibility* (teacher will model reasoning through a conceptual connection).

Day 2:

1) **Do Now**

Students will review what they took notes on the previous day and add to their notes. They will talk with members of their groups to get feedback and note what stood out to them. Entrance slip: Students will write their beginning thinking about our essential question.

2) **Synthesis**

Students will begin to put together what they learned from the resources into a claim/argument. They will prepare to explain their individual arguments to their group and then reach consensus within their group about the argument they will present to the other students.

3) **Round 1 Positions**

Students who are in the "against" group will present to the other students first, and the students in the "for" group will just listen. Those students will be able to record what stands out to them about the arguments from the :against" group. They will present for 2-3 minutes and then switch. Time will also be given to ask clarifying questions (modeled by the teacher).

4) **Round 2 Positions**

This time the "against" students will present their positions first. Students in the "for" group will record what they find important in the other group's arguments. The groups will switch. Time will once again be given for clarifying questions.

5) **Discussion and Consensus**

In their assigned groups, students will discuss their own opinions about whether use of nuclear energy is justified. Then each group will have a representative report to the whole group to discuss and try to reach consensus. The teacher will assess whether students cite evidence and refer to one another's analyses within the discussion. The discussion will conclude with a reference back to our essential question, and students will add to the entrance slip document, while being encouraged to write how additional information from our discussions and presentations added more to their thinking.

Setting the Stage

“The United States emits an immense amount of carbon dioxide into the atmosphere. According to the Intergovernmental Panel on Climate Change, it is *extremely* likely that the rising global temperature trends since the mid-20th century is **dominantly due to human activity**. No scientific organization of national or international standing disputes this. Furthermore, the US Department of Defense has officially stated that climate change poses **a serious national security threat**. In light of all of this, the United States recently ratified the Paris Climate Agreement, which means we are **committed to significantly reducing our carbon emissions**. How do we do that?

Given that, in 2015, we released 2 billion metric tons of carbon dioxide (CO2) from electricity generation alone, and fossil fuels accounted for **over 99% of these emissions**, a great place to start would be to begin replacing fossil fuel power plants with alternative energy sources. The main alternatives are solar, wind, and nuclear. The first two are certainly alluring, attracting the investment of a lot of government money worldwide. However, they are also variable. The wind isn’t always blowing; days aren’t always clear and sunny. This isn’t to say relying solely on renewables is impossible or even unrealistic with some clever storage and transportation strategies. However, it is a challenge to replace the constantly running fossil fuel power plants with sources that are intermittent.

Ideally, we’d have a source that doesn’t emit CO2 *and* is consistently reliable; this is known as a baseload energy source. In this context, nuclear energy is the main alternative energy source that works. Yet, unlike its fickle counterparts, nuclear energy is subjected to hostile attitudes adopted by a number of governments in the world which restrict the building or continual operation of power plants. Fear for Chernobyl and Fukushima-type catastrophes exacerbate the unpopularity of going nuclear. The US, currently the world’s largest producer, relies on nuclear energy for **20% of its overall electricity generation**. Yet there has historically been a strong anti-nuclear movement in the US, and the sentiment is still somewhat present today, as demonstrated by **closures of nuclear power plants** and stances held by prominent political figures such as Vermont Senator **Bernie Sanders**.” - excerpt from article “Reconsidering the Risks of Nuclear Energy” by Jordan Wilkerson, Harvard University

Possible Resource for Information on Setting the Stage -

https://www.blendspace.com/lessons/K6qBeYaHGxipiQ/structured-academic-controversy-nuclear-energy

https://www.nationalgeographic.com/environment/article/nuclear-energy?loggedin=true

Against Nuclear Energy

Union of Concerned Scientists Resources -

https://www.ucsusa.org/energy/nuclear-power

https://www.ucsusa.org/resources/preventing-american-fukushima

https://www.ucsusa.org/resources/nuclear-power-dilemma

Excerpts from *Downwind: A People's History of the Nuclear West*

Excerpts from *Wastelanding: Legacies of Uranium Mining in Navajo Country*

Excerpts from *Behind the Fog: How the U.S. Cold War Radiological Weapons Program Exposed Innocent Americans*

Chernobyl text

Effects of radiation on the body - food

Radioactive Baby Teeth

Hibakusha - film

https://en.wikipedia.org/wiki/Shuntaro_Hida

For Nuclear Energy

https://foreignpolicy.com/2022/01/03/nuclear-energy-climate-policy/

https://e360.yale.edu/features/why-nuclear-power-must-be-part-of-the-energy-solution-environmentalists-climate

https://robertstoneproductions.com/project/pandoras-promise/