The Power of an Atom - India pilot

OVERVIEW

In this lesson, students learn that nuclear energy is powerful enough to send a robot on a scientific mission millions of kilometers (miles) away and to supply large amounts of electricity on Earth with minimal impacts on natural resources. They also learn that harnessing the power of the atom has consequences—some very serious and long-term consequences. Rather than telling students what to think about the issue, the lesson encourages students to research the topic and then debate their peers. The lesson concludes with a discussion designed to help students synthesize their thoughts on the topic.

KEY OBJECTIVES FOR STUDENTS:

- Define nuclear energy, and explain why it is useful.
- Describe the risks of nuclear energy.
- Research and articulate the pros and cons of using nuclear energy.

ESTIMATED TIME NEEDED (MINUTES):

- 100 minutes

GRADE LEVELS:

5, 6

PRIMARY SUBJECTS:

Civics and Government, Science

SECONDARY SUBJECTS:

Environmental Education, Reading or Language Arts

TOPICS:

nuclear power, Atomic power, Mars rover, plutonium, uranium, radioisotope thermoelectric generator, space battery, Electricity, fission, turbine, pollution, global warming, greenhouse gases, Acid precipitation, Alternative resource, mining, sustainable, renewable, nonrenewable, radioactive waste, meltdown, Fukushima, radiation

METHODS:

Brain-Based Learning, Multi-Disciplinary, Multiple Intelligences, Real-World Application, Technology Integration

SKILLS:

Collaboration, Communication skills, Critical Thinking, Digital citizenship, Systems thinking

VALUES:

Curiosity, Global Leadership, Mindfulness, Optimism
BACKGROUND INFORMATION FOR TEACHERS:
In this lesson, students tackle the complex issue of nuclear power and whether the benefits outweigh the risks. The lesson provides an important opportunity for students to role-play a community leadership position by assuming the role of a city council member. They then research the issue and defend a point of view. By the end of the activity, students vote as individuals, not necessarily in support of their team but rather in support of their conscience. Through this exercise, students learn to remain open-minded and to consider all points of view before making a decision. In a final discussion, the lesson encourages students to think about and articulate the rights and responsibilities of citizens and leaders. They also have ample opportunity in this lesson to learn the importance of equity, cooperation, teamwork, conflict resolution, and consensus building in addressing regional and global challenges.

PREVIOUS SKILLS NEEDED:
- Research and communication skills are helpful
- Understand the terms atoms and molecules and how the configuration results in formation of elements and compounds

IN ADVANCE:
Review the presentation and corresponding teacher’s notes in advance, and ensure that you have the necessary equipment to show the presentation on the first class day. Also ensure that students have access to the Internet or a library so they can do research on nuclear energy. You should determine in advance how you will divide the class into groups. So that you can give students guidance on effective avenues for research and credible information online, consider researching nuclear power yourself and providing a list of websites that students could use. A list of several websites is located in the External Resources section of the Extend tab.

MATERIALS NEEDED:
Class 1:
- Student access to the Internet or a library for research

KEY VOCABULARY:
nuclear power
atomic power
electricity
fission
turbine
pollution
global warming
greenhouse gases
acid precipitation
alternative resource
mining
renewable
nonrenewable
radioactive waste
radiation
ACTIVITY OUTLINE:

Class 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 minutes</td>
<td>Introduction</td>
<td>Show the presentation to give students an overview of nuclear energy.</td>
</tr>
<tr>
<td>30 minutes</td>
<td>Research</td>
<td>Students choose a position, form teams, and begin researching the issue in greater depth.</td>
</tr>
<tr>
<td>5 minutes</td>
<td>Plan</td>
<td>Teams plan their strategy for the debate and issue homework assignments if necessary.</td>
</tr>
</tbody>
</table>

Class 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 minutes</td>
<td>Preparation</td>
<td>Give students time to review their notes and consolidate a strategy.</td>
</tr>
<tr>
<td>30 minutes</td>
<td>Debate</td>
<td>Students debate the motion.</td>
</tr>
<tr>
<td>5 minutes</td>
<td>Vote</td>
<td>Students vote on the motion.</td>
</tr>
<tr>
<td>10 minutes</td>
<td>Discussion</td>
<td>Conclude with a final discussion that consolidates students’ learning and helps them understand the value of the exercise.</td>
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</tbody>
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IMPLEMENTATION:

Class 1:

1. **Introduction**: Show students The Power of an Atom Presentation, using the Teacher’s Notes as a guide to encourage engagement and participation. (Both documents can be found in the Downloadable Resources section on the Prepare tab.) The presentation is designed to get students thinking about the pros and cons of nuclear energy without delving into the topic in too much detail.

2. The final page of the presentation encourages students to take a stand on one side or the other of the debate. When you arrive at the last page, call for students to raise their hand if they think—at this point—that they support nuclear energy. Then ask those who are against it to raise their hand. If the class is fairly evenly divided, tell students you would like them to do research in preparation for defending and supporting their chosen point of view. If the division is not even, you may want to assign half the students to the “pro” position and half to the “con” position.

3. Further divide the class into four teams, two for each side of the debate.

4. **Research**: Encourage students to work together as a team to research the issue in depth. Formally introduce the debate topic as follows: Suppose you are a city council member. A motion has been made to build a state-of-the-art nuclear power plant to meet the electric power demands of your community. The necessary funds and an ideal location are available.

5. Tell students if they are for nuclear power (or were assigned to that position), they must defend the power plant. If they are against nuclear power (or were assigned to that position), they must argue against the building of the plant. Whatever their position, they need to formulate a well-reasoned opinion that is substantiated with facts and examples.

6. Explain that in the next class period students will debate the issue with other city council members (represented by their classmates). Give each student a copy of the Nuclear Debate Rubric so all students know how you will assess them for this assignment.

7. Have students gather with their team and begin by talking as a group about their point of view. Give each student a copy of the Nuclear Debate Worksheet to help them get started with some key questions. You may wish to walk around while students are planning, to check their progress. Use the Nuclear Power Cheat Sheet if students are struggling to outline their position or lack information about the opposing point of view. Tell students that preparing for an effective debate means having an understanding of both points of view.

8. Give students time to do research. Teams should plan to consolidate their key points and research in an organized way, such as on note cards or in a presentation they can share with the council. Tell them each person will be expected to contribute during the debate.

9. **Plan**: Explain that in the next class period, the teams will have five minutes to consolidate their thoughts, and then they will all debate the issue. At the end of the debate, council members (the entire class) will vote to see whether the nuclear energy
motion passes or fails.

10. Encourage students to do more research for homework if they feel the need to do so. Remind them that all team members will speak during the debate, so all should be prepared. Teams may want to assign each team member a specific point on which to do further research, or teams could plan to meet outside of class to prepare and collaborate further.

Class 2:

1. **Preparation**: Give teams five minutes to discuss their main talking points and coordinate strategy for effectively sharing and supporting their point of view.

2. **Debate**: Organize the classroom into four areas, and assign each team an area. Have a council member from one team stand and present an argument in support of that team’s position. Then have a council member from an opposing group stand and deliver a counterargument. Continue until all council members have had an opportunity to speak and each team has delivered their full argument.

3. **Vote**: Call for a vote on the motion to build a nuclear power plant in the community. Call for a student to second the motion. Tell students that for the vote, rather than maintaining the position they argued for with their team, you would like them to vote as individuals who have heard all the arguments and are now making a decision based on what they feel is right. In other words, it’s ok to switch sides for the vote. You can conduct a secret ballot by distributing slips of paper and asking students to write “Yes” if they support the motion or “No” if they do not support the motion. Or call for all students who support the motion to raise their hands. Count the results and determine if a majority of the class supports the motion. If so, the motion has passed. If not, the motion fails.

4. **Discussion**: Ask students what they think and feel about the outcome of the debate. Stimulate discussion about the process and whether students enjoyed serving as leaders for their community. Use the Reflection Questions on the Assess tab as a guide.

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**ADDITIONAL TEACHING TIPS:**

This lesson is set up for students to research the topic during the first class period and then debate the topic in the second. However, you may want to give students more time to conduct research so they can better prepare for the debate. You could also ask teams to prepare audiovisual presentations that summarize their point of view. Alternatively, you could condense the two class periods into one by assigning each team one argument (such as one of those listed on the Nuclear Power Cheat Sheet), giving them a few minutes to research that argument and organize themselves, and having each team defend their position by briefly presenting what they learned.
REFLECT

REFLECTION QUESTIONS:
Use the following questions to prompt critical thinking and guide students to reflect about the lesson:

• Do you believe nuclear power is good or bad? Explain. (Sample answer: Nuclear power has some obvious benefits and some serious drawbacks. Some countries have chosen to invest in nuclear power because they believe they can use it safely and that the benefits outweigh the costs. But even if nuclear power is made safe and a way is found to store the hazardous waste safely, there is still the issue of mining and the environmental impact that comes from extracting uranium-235.)

• Did your opinion change during the course of your research or the debate? Which arguments were the most compelling, and why? (Sample answer: I started out thinking nuclear energy was a bad thing. But after studying about greenhouse gases and global warming trends, I think we need to look seriously at options that do not worsen that problem.)

• You simulated a governmental process that takes place all over the world. How do you feel about serving as a community leader who makes decisions for the community? (Sample answer: At first I was very nervous about participating because I don’t like public speaking. But then I relaxed and realized that what we were talking about was important and that everyone’s contribution mattered.)

• How do you feel about other people making decisions for you and your community? Do you think your local government is well equipped to make decisions for your community? Explain. (Sample answer: I don’t really know what kind of leaders we have in our community, but I hope they are thoughtful ones. I think I will start paying more attention from now on.)

• What has this experience taught you about the qualities needed for effective leadership in your community? (We need leaders who can listen, with an open mind, to the points of view of others; they should also be able to do research and educate themselves on the facts of important issues; they should sincerely care about the needs and future of the community and not just about what serves their own best interests now.)

ASSESSMENT OPPORTUNITIES:
There are many opportunities for assessment in this lesson. Give students the Nuclear Debate Rubric before they begin their preparation so they know in advance what you will be looking for. Then pay attention to students’ participation and involvement while they research in groups and discuss during the debate. You can also review the information they record on their Nuclear Debate Worksheets. Then use the Nuclear Debate Rubric Class Results to record rubric results for each student. The ideas suggested on the Extend tab also offer valuable opportunities for assessment.

STANDARDS ASSESSMENT:
Learning indicators

• Explore surrounding and shares experiences with others
• Asks questions leading to investigations

Reporting and Recording

• Identifies relationships in the findings

Discussion

• Presents logical explanations and arguments,
• Communicates conclusions clearly
• Connects scientific concepts to everyday life
• Makes effort to acquire further knowledge
• Responds critically to media coverage of issues
• Shows some problem solving skills

Demonstrates values imbibed

• Records and report’s findings honestly
• Takes responsibility and initiative while performing task
• Works cooperatively with peers
• Listens patiently to arguments of others
• Advises the ways for conservation of environment so that changes in environmental conditions will not affect the survival of entire species.

Learning Indicators in Science at Upper Primary Stage
COMMUNITY CONNECTIONS:
Encourage students to invite experts from the community to come to the classroom and debate the issue. For instance, they could invite a city council member, a representative from a nuclear power plant, a college professor who teaches nuclear engineering, and an activist who is known for campaigning against nuclear power. Each visitor could make opening and closing remarks; in between, students could ask prepared questions of one visitor and allow the others to respond. Afterward, encourage students to write a paragraph or two describing how this debate compared to their own and whether their opinion changed at all.

DIFFERENTIATION:
If students are academically advanced, encourage them to use their research skills to look for valid and reliable websites on their own without giving them a list of suggested websites. Students who struggle with the vocabulary in this lesson may benefit from creating flashcards of the Key Vocabulary terms or having an after-class vocabulary review session. Suggest that second-language learners translate each vocabulary word into their primary language first, review the definition in their native language, and then write down the English terms and definitions to review and study.

CROSS DISCIPLINARY CONNECTIONS:

Reading or Language Arts
- Suggest that students write an editorial about whether a nuclear power plant should be constructed to provide electricity for your community. Arrange to have the strong letters published in the school newspaper or a school newsletter.
- Find out if there is any political activity in your area around the issue of nuclear power or uranium mining. Give students a lesson on persuasive letter writing, and then encourage them to write their representatives a letter in which the student shares his or her point of view about whether the actions should stop or continue.

Mathematics
Have students create infographics to compare nuclear power with at least one other type of power generation, such as coal-fired power plants. They could gather and use data about the average amount of water each type of plant needs and the average amount of waste it generates for each kilowatt it produces, the total number of each type of plant in existence around the world, the amount of power generated by each type of plant, etc. Encourage them to find creative ways to compare and graphically describe this information.

Socio Political Life
- Students could research how nuclear disasters have affected the communities of Chernobyl, Fukushima, and Three Mile Island, as well as accidents at nuclear power plants in India. Students could share their results in the form of a presentation to the class. Encourage them to include a discussion about how supporters of nuclear energy respond to those who believe the risk of future accidents is too great to justify nuclear energy.
- Direct students to research the emergency plans currently in place to address an accident or disaster at a nuclear facility, such as Nuclear Emergency Response from the Government of India's Department of Atomic Energy.
- Students could research individuals who have served as leaders of citizen movements related to nuclear energy issues, both locally and globally. Encourage them to write an essay in which they summarize what they learn and reflect on the rights and responsibilities of democratic participation and leadership.

CULTURAL ADAPTATION NOTES:
If nuclear power isn’t used in your country, reframe the debate as being about whether nuclear power would be a better option for your country than the methods currently used to generate electricity. This activity encourages students to role-play members of a city council. If that terminology is not used in your community, substitute more familiar terminology to make the exercise more relevant to students.