

National MagLab

STEM Lesson Plan:

Using the National Mag Lab to Support Environmental Justice:



Exploring the Role of Science in Addressing Injustice (High School)

Purpose:

This lesson plan is designed to emphasize the vital role of science in identifying, addressing, and mitigating environmental injustice, thereby fostering a deeper understanding of the critical intersection between scientific inquiry and social justice. By exploring how scientific principles can be applied to recognize disparities in environmental quality and access to resources, students will gain insight into the systemic inequities that impact marginalized communities.

Furthermore, this lesson encourages students to engage with real-world examples of environmental injustice, such as pollution, access to clean water, and the effects of climate change on vulnerable populations. Through collaborative discussions, hands-on activities, and critical analysis of case studies, students will develop the skills to evaluate data, draw connections between scientific findings and social issues, and propose actionable solutions to promote equity and sustainability. Ultimately, this lesson aims to empower students to recognize their potential as informed citizens and advocates for social and environmental justice in their communities.

Next Generation Science Standard:

- MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- MS-ESS3-3 Earth and Human Activity. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- HS-ESS3-4 Earth and Human Activity. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

STEM RATIONALE FOR LESSON:

Students will gain a comprehensive understanding of the pivotal role that science plays in addressing cases of environmental injustice. They will explore how scientific methods can be effectively employed to identify, analyze, and propose solutions to the

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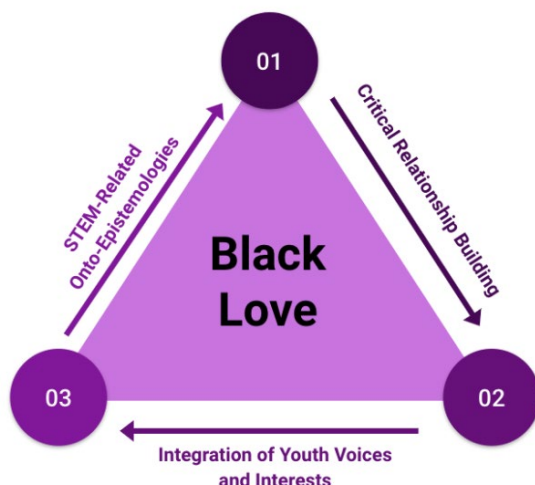
systemic inequities faced by marginalized communities. By examining real-world scenarios, students will learn to utilize data collection, analysis, and interpretation to uncover the underlying factors contributing to environmental disparities.

Additionally, students will investigate how interdisciplinary approaches—integrating fields such as ecology, sociology, and public policy—can contribute to the development of equitable and sustainable solutions. Through collaborative projects and critical discussions, they will engage with current environmental challenges, evaluating existing initiatives and proposing innovative strategies that prioritize fairness and sustainability. Ultimately, this exploration will empower students to appreciate the transformative potential of science as a tool for social change, equipping them with the knowledge and skills necessary to advocate for environmental justice in their communities and beyond.

Culturally Responsive Connection:

Drawing on the pedagogical principles outlined in Worsley’s Black Love Framework (2021) and the scientific expertise provided by the National MagLab, this lesson plan aims to empower students to design and conduct a comprehensive scientific investigation that utilizes the National MagLab’s facilities to address a specific case of environmental injustice. By fostering a deeper understanding of both scientific inquiry and social equity, the lesson encourages students to actively engage with pressing environmental issues.

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To build this capacity, the lesson will incorporate a series of spiraling activities that progressively enhance students' knowledge and application skills across a range of interconnected topics. These activities will not only deepen their understanding of scientific methods and principles but also emphasize the importance of cultural relevance and social justice in scientific exploration. Key topics will include:

- **Environmental Data Analysis:** Students will learn to collect, analyze, and interpret data related to environmental conditions and injustices, enhancing their ability to identify patterns and draw meaningful conclusions.
- **Interdisciplinary Approaches:** The lesson will highlight the value of integrating scientific, social, and historical perspectives to develop a holistic understanding of environmental issues and their impacts on diverse communities.
- **Ethics in Science:** Discussions will focus on the ethical considerations of conducting research in communities affected by environmental injustice, ensuring that students appreciate the importance of respectful engagement and collaboration.
- **Modeling and Simulation:** Students will explore various modeling techniques to visualize and predict the outcomes of their investigations, fostering critical thinking and problem-solving skills.
- **Communication of Findings:** The lesson will emphasize the importance of effectively communicating scientific findings to diverse audiences, including policymakers and community members, to advocate for change and promote awareness of environmental justice issues.

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Through these carefully designed activities, students will not only develop their scientific skills but also cultivate a sense of agency and responsibility toward addressing environmental injustices in their own communities and beyond.

Materials needed (for each group):

- Case studies on environmental injustice cases (e.g., water contamination, air pollution, etc.).
- Whiteboard and markers
- Internet access for research
- Notebooks and pens for students

Engage (25 Minutes):

1. **Define Environmental Injustice:** Begin by clearly defining environmental injustice as the inequitable distribution of environmental benefits and burdens, which disproportionately affects marginalized communities. Emphasize how factors such as race, socioeconomic status, and geographic location contribute to these disparities in access to clean air, water, and safe living environments.
2. **Discuss the Connection to the Scientific Method:** Engage students in a discussion about how the scientific method serves as a powerful tool for identifying, analyzing, and addressing environmental injustices. Explain that through systematic observation, data collection, and analysis, scientists can uncover the root causes of environmental issues and develop informed, effective solutions. Highlight examples where scientific research has successfully brought about change in affected communities.
3. **Pose a Guiding Question:** Introduce the central inquiry question: “How can scientific methods be used to address and rectify environmental injustice?” Encourage students to think critically about the role of science in promoting social equity and environmental sustainability.
4. **Create a KWL Chart:** Instruct students to create a KWL (Know, Want to know, Learned) chart to organize their thoughts on the role of science in addressing environmental injustice. This chart will serve as a valuable tool throughout the lesson.

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5. **Know Column:** In the "Know" column, ask students to jot down what they already understand about the connection between science and environmental injustice. Encourage them to draw on personal experiences, current events, or previous lessons to populate this section.
6. **Want to Know Column:** In the "Want to Know" column, have students list questions or topics they are curious about regarding how scientific methods can be applied to combat environmental injustice. This could include inquiries about specific case studies, scientific techniques, or the impact of research on policy and community action. This brainstorming session will help to guide the lesson and ensure that it addresses students' interests and curiosities.

Explore (50 Minutes):

1. **Divide the Class into Small Groups:** Organize students into small, diverse groups to encourage collaboration and the exchange of ideas. Aim for groups of 4-5 students to foster meaningful discussions.
2. **Provide Case Studies:** Distribute a variety of case studies on different instances of environmental injustice, ensuring that each group receives a unique scenario. These case studies should cover a range of issues, such as water contamination, air pollution, waste disposal, or land use disputes, highlighting the diverse impacts of environmental injustices on various communities.
3. **Analyze Scientific Methods:** Instruct each group to analyze their assigned case study by considering how scientific methods were utilized or could have been employed to address the environmental injustice presented. Encourage them to examine the research techniques used, the type of data collected, and the overall impact of the findings on community awareness and policy changes. Students should consider questions such as:
 - a. What scientific methods were used to investigate this issue?
 - b. How did these methods contribute to understanding the environmental impact?
 - c. What alternative scientific approaches could have been beneficial?
4. **Group Presentations:** After the analysis, have each group present their findings to the class. Encourage them to summarize their case study, the scientific

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methods involved, and their thoughts on the effectiveness of those methods in addressing the injustice.

5. **Class Discussion:** Facilitate a class-wide discussion that delves deeper into the role of scientific evidence in identifying and resolving environmental injustice issues. Highlight key themes from the presentations and encourage students to engage with one another's findings.
6. **Exploration of Limitations and Challenges:** Encourage students to critically examine the limitations and challenges associated with using scientific methods in addressing environmental injustices. Discuss factors such as:
 - a. The accessibility of data and research for marginalized communities.
 - b. Potential biases in research design or interpretation.
 - c. The need for interdisciplinary approaches that incorporate social, economic, and cultural factors alongside scientific analysis.

By fostering an open dialogue around these topics, students will develop a nuanced understanding of the complexities involved in leveraging science to combat environmental injustice, as well as the importance of equitable practices in scientific research.

Explain (20 Minutes):

1. **Lead a Discussion on Science's Role in Addressing Environmental Injustice:** Begin by asking students to share their thoughts on how science plays a crucial role in combating environmental injustices. Highlight examples such as:
 - a. **Environmental Monitoring:** Discuss how scientists use tools and techniques to track pollution levels, monitor air and water quality, and gather data on ecosystem health in communities affected by environmental injustice.
 - b. **Health Studies:** Explore how scientific research can reveal the links between environmental exposure (e.g., toxins, pollutants) and public health outcomes, particularly in marginalized communities.
 - c. **Policy Recommendations:** Highlight how scientific evidence is essential in influencing policymakers to enact regulations that protect vulnerable populations from environmental hazards, using scientific findings to advocate for justice.

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2. **Introduce the Role of the National MagLab:** Present the cutting-edge scientific research conducted at the National MagLab and explore how its resources can contribute to solving environmental injustice. Discuss potential applications such as:
 - a. **Advanced Environmental Monitoring:** Explain how the National MagLab's technologies could be used to monitor environmental pollutants at a more precise level, providing critical data for affected communities.
 - b. **Innovative Materials Science:** Highlight the Lab's research in materials science and how it could be applied to developing sustainable technologies or solutions that reduce environmental impacts in underserved areas.
 - c. **Educational Outreach:** Discuss how the MagLab's commitment to science education and outreach can empower students and communities with knowledge to advocate for environmental justice.

By connecting scientific research with broader social and environmental issues, students will gain a deeper understanding of the collaborative efforts needed to address and rectify environmental injustice. This discussion will encourage them to think critically about their role as future scientists and advocates for change.

Extension: Discuss the importance of Interdisciplinary approaches to finding solutions. Emphasize that solving environmental injustice requires more than just scientific expertise—it demands interdisciplinary collaboration that incorporates social, economic, and cultural considerations. Facilitate discussion on:

- d. **Social and Economic Factors:** Ask students how socioeconomic status, race, and geography can exacerbate environmental injustice, and how understanding these factors is crucial for creating meaningful, long-term solutions.
- e. **Community Engagement:** Discuss how working closely with affected communities ensures that their voices, experiences, and cultural contexts are integrated into scientific research and solutions.
- f. **Collaboration with Other Disciplines:** Encourage students to think about how scientists can collaborate with sociologists, economists, policy makers, and public health experts to address the complex nature of environmental injustice.

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Elaborate:

1. **Group Assignment:** Divide students into groups, assigning each group a specific environmental injustice case to research. Cases may range from issues like industrial pollution, water contamination, or disproportionate exposure to hazardous waste in marginalized communities. Each group is tasked with proposing scientifically grounded solutions to address the injustice.
2. **National MagLab Instrument Integration:** Instruct students to incorporate an instrument or technology from the National MagLab into their solution. This could include tools for precise environmental monitoring, advanced materials science, or other relevant applications that highlight the Lab's cutting-edge capabilities. Encourage creativity in thinking about how these technologies can be applied to real-world problems.
3. **Evidence-Based Proposals:** Emphasize that the proposed solutions must be grounded in scientific evidence. Guide students to use reliable data, research findings, and case studies to support their recommendations. Proposals should also account for the socioeconomic and cultural context of the affected communities to ensure that the solutions are equitable and sustainable.
4. **Community Impact Focus:** Highlight the importance of considering the needs and voices of the communities impacted by environmental injustice. Encourage students to explore how their proposed solutions would benefit these populations and contribute to long-term environmental and social well-being.

By conducting research and crafting solution proposals that incorporate scientific tools from the National MagLab, students will not only deepen their understanding of environmental justice but also learn how to apply advanced scientific concepts to real-world challenges.

Evaluate:

1. **Student Presentations:** Each student or group will present their research findings and proposed solutions to the class using their preferred format, whether it be digital slides, posters, videos, or another medium. Encourage students to be clear, concise, and informative, focusing on the scientific methods they applied and their proposed solutions.

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2. **Peer Review and Feedback:** After each presentation, engage the class in a peer review process. Encourage constructive feedback on the scientific rigor of the proposals, as well as their feasibility and potential impact on affected communities. Ask students to evaluate how effectively each group applied scientific methods and how well they integrated community needs into their solutions.
3. **Assessment and Reflection:** To assess individual understanding, students will write a reflection based on the following rubric:
 - a. **Understanding of Science's Role:** Does the student clearly explain how science can address environmental injustice cases?
 - b. **Application of Scientific Methods:** How well does the student explore the role of scientific methods in creating equitable and sustainable solutions?
 - c. **Critical Thinking:** Has the student engaged in critical thinking by analyzing the complexities of environmental injustice and proposing thoughtful solutions?
 - d. **Connections Between Science, Equity, and Sustainability:** Does the student offer insightful reflections on the links between science, social equity, and sustainability?
 - e. **Evidence-Based Support:** Are the student's reflections supported by relevant evidence, research, and credible sources?
 - f. **Use of Credible Sources:** Has the student demonstrated an understanding of the topic through the use of accurate and credible references?

This process allows students to not only present their work but also critically engage with their peers, enhancing their understanding of how science can be a tool for equity and justice in real-world situations.

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**Research Experiences
FOR TEACHERS**

Exploring the Role of Science in Addressing Injustice Grading Rubric:

20% Understanding of the role of science in addressing environmental injustice.

- Demonstrates a clear understanding of how scientific methods can be utilized to address environmental injustice issues.
- Incorporates relevant concepts, theories, and examples to support arguments.

20% Ability to analyze and articulate how scientific methods can be applied to specific cases.

- Provides a thorough analysis of a specific environmental injustice case.
- Articulates how scientific methods, including those from the National Maglab Science lab, can be applied to propose solutions.
- Provides evidence-based reasoning and critical thinking.

15% Engagement in class discussions and group activities.

- Actively participates in class discussions, contributing meaningful insights and perspectives.
- Collaborates effectively with peers in group activities, demonstrating teamwork and cooperation.

25% Quality of research and presentation skills in the follow-up project.

- Conducts comprehensive and well-researched work on the assigned environmental injustice case.
- Utilizes reliable sources and references to support findings.
- Demonstrates effective presentation skills, including clear organization, use of visuals, and engaging delivery.

10% Application of an instrument from the National Maglab Science lab.

- Proposes a scientific solution that includes the application of an instrument from the National Maglab Science lab.
- Demonstrates understanding of the instrument's capabilities and relevance to the case study.

10% Emphasis on evidence-based recommendations that consider affected communities.

- Considers the perspectives and needs of the affected communities in proposing recommendations.
- Ensures that recommendations are evidence-based and ethically sound.

Overall Score 100% _____

Comments: (Provide feedback on strengths and areas for improvement: