Human Waste and Environmental Impact: Causes, Effects, and Solutions

Unit	Utah SEEd Standard / NGSS Performance Expectation	Estimated Lesson Time:
Bio 1.5 Ecology	Design a solution that reduces the impact caused by human activities on the environment and biodiversity. *Define the problem, identify criteria and constraints, and develop possible solutions using models. Analyze data to make improvements for iteratively testing solutions and optimize a solution*.	**120 minutes** Designed to cover 2 days of instruction with an optional 3-day extension (optimizing the solution).

Access to all material for this lesson: https://byu.box.com/s/agx67kf9esnjmtiqtg3haqnl3qnct9xw

LESSON OVERVIEW

Lesson Objective(s)

Design a solution that reduces the impact caused by human activities on the environment and biodiversity.

Anchor Phenomenon

Students see the human causes and the effects they have on the environment.

Driving Question(s)

What are the causes and effects of human waste on the environment?
What are potential solutions for negative impacts on the environment and biodiversity from human waste?
What are the potential limitations of addressing the issue of human waste?

Lesson Level Performance Expectations

- Cause and effect shows data on human environmental activities by designing solutions using models.

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LESSON SNAPSHOT

LESSON SUMMARY: Students will design a solution to address the cause and effect of waste on the environment while considering various constraints and criteria.

	Estimated Time	Section Overview	How are students answering the driving question or meeting the learning objectives? (SEPs, DCIs, and CCCs)
Day 1 **Experience the Phenomenon**	**35 min**	- Spiral review (5 min) - Day of garbage visual (10 min) - Talking about cause and effect of human waste on the environment (10 min) - Choosing problem (10 min)	Students see the human causes and the effects they have on the environment. Students are identifying a problem based on this information.
Day 1 **Investigate the Phenomenon**	**25 min**	- Teacher solution example (5 min) - Constraints (10 min) - Research (10 min)	Students are analyzing an example solution to see the importance of constraints.
Day 2 **Model the Phenomenon**	**60 min**	- Design solution (25 min) - Create solution model (30 min) - Evaluate using the provided rubric (5 min)	Students design a solution that is limited by certain constraints. They focus on how their solution will reduce the negative effects of human waste and benefit the environment and its biodiversity.

DISCIPLINARY CORE IDEAS	& ENGINEERING PRACTICES	CROSSCUTTING CONCEPTS
NGSS Appendix E Define the problem given a set of criteria and constraints to determine possible solutions using models that reduce the impact caused by human activities on the environment (landfill).	NGSS Appendix F Constructing Explanations and Designing Solutions	NGSS Appendix G Cause and Effect
Related knowledge and skills from prior grades		
Disciplinary Core Idea: NGSS Appendix E Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)	Science and Engineering Practices NGSS Appendix F Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	Crosscutting Concept: NGSS Appendix G They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They recognize changes in systems may have various causes that may not have equal effects.

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Materials

Student Materials	Teacher Materials	Lab Materials/Other Resources
Waste Management Student Handout Group Solution Handout Waste Management Solution Rubric Optimize a Solution Extension Activity Definitions and Examples of Constraints	Teacher Slides Create a way for students to report results of how much garbage they are using (i.e., a QR code link)	- Research Articles Links - Project materials for posters, pamphlets, etc. - 24 hours of garbage for visual exposure to the phenomenon

Lesson Preparation

Material Preparation:

- Print: Waste Management Student Handout, Group Solution Handout, and Waste Management Solution Rubric
- Gather 24 hours' worth of garbage
- Create and ensure a QR code is linked to a source for survey results
- Post research articles on Canvas for students to access.

Required Previous Knowledge:
This lesson builds on the student's prior understanding of the following Utah Biology SEEd Standards: BIO.1.1 - BIO.1.4

Supports students will need/adaptations:
As students work on solution designs, ask questions to clarify their design. Ask leading questions to help them refine/improve their design.

Vocabulary Definitions: Ecosystems, Biodiversity, Constraints, Criteria, Environment, Model, Solution Designs, Human Waste, Waste Management

Experience the Phenomenon/Problem

What Students Are Doing	Teacher Tips
Recall what has been covered from BIO.1.1-BIO.1.4 before seeing the phenomenon. **Part 1:** What do you see, think, and feel based on one day's worth of garbage? **Part 2:** Identify two problems based on environmental impact as individuals. (sticky notes or Padlet) **Part 3:** Choose the two best problems as a small group.	 Part 1: Think, pair, share Part 2: Pens with No Friends or Padlet with votes

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What Teachers Are Doing	Teacher Tips
Quick spiral review of BIO.1.1-BIO.1.4 focusing on the connections to biodiversity and environment. **Part 1:** Display a day's worth of garbage in a clear bag. You can take it out to show the different types of waste. **Part 2:** Show pictures, slides, or articles of unmanaged waste, dumpsters, landfills, and global-scale problems. Comment on what problems we see as the class experiences the additional resources. **CCC:** What is the cause and effect of human waste on the environment? **Part 3:** Collect the best group problems and work with them as a class to focus on one problem. **Ensure the chosen problem is centered on the environmental impact caused by humans.**	See slide notes for help with each slide. **Part 1**: Collect 24 hours' worth of garbage to illustrate how much waste humans can produce. **Part 2: Municipal Waste Fun Facts** - More than half the world's population does not have access to regular trash collection. (source) - The US creates over 624,000 metric tons of waste per day. (source) - Nevada generates the highest amount of waste per person: 38.4 tons. (source) - The US threw out over 292 million tons of trash in 2018. (source) - The US spends about $200 billion annually on solid waste management and lost energy resources from trash disposal. (source) - The United States Municipal Solid Waste Management Market is expected to surpass $25 billion by 2024. (source) - Annual waste generation is expected to increase to 3.4 billion metric tons by 2050. (source) - The average American produces, on average, 4.9 lbs of garbage daily, which equates to approximately a 13-22 gallon garbage can every day (depending on the type of waste). (source) Cue thinking about where the trash goes, what is in it, biodegradable content, etc. **Part 3**: Remind students that problems should focus on environmental impact.

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INVESTIGATE THE PHENOMENON

What Students Are Doing	Teacher Tips
- Students will learn what a constraint is. - After analyzing the teacher-given example, students will identify the constraints. - Students will discuss the importance of constraints. - Students in their small groups will receive the environmental constraint with one other constraint from the teacher. - In their small groups, students will spend time individually researching various real-world solutions.	Guide the discussion to generate a constraint list.
What Teachers Are Doing	**Teacher Tips**
- Define what a constraint is. - Provide an example solution to begin the conversation regarding constraints when building solutions. - Go through each constraint as a whole group and ask about the importance of it. o **CCC:** "What would be a negative effect if this constraint was ignored?" - Give each small group of students two constraints to consider when creating their solution. (1. Environmental, and 2. an additional constraint chosen from the list of constraints) - Provide students with time (~10 min.) to research real-world solutions that are being implemented.	Definitions and Examples of Constraints

MODEL THE PHENOMENON

What Students Are Doing	Teacher Tips
- Students will design a solution that reduces human activities' negative effects on the environment. - Students work in small groups to find a solution that meets the criteria while staying within the two constraints provided to them by the teacher. - Students will then model their phenomenon using various mediums (PowerPoint, Poster, etc.) - Students will use the rubric to evaluate their solutions. - Students will present their solutions to the class for review.	Ensure students stay focused on the problem they need to fix, the design of their solutions, and the benefits it will provide for the environment and biodiversity.

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What Teachers Are Doing	Teacher Tips
- Present an example solution product for students to see expectations. - Go over the rubric and criteria with the whole class. - Have each small group of students work together to create a solution. - Encourage each group to work within the two provided constraints. - Remind students to have their solution meet the criteria provided in the rubric. - Use rubrics to assess students' solutions.	As students design solutions, go around to each group and ask clarifying questions to help guide their solutions from rough draft ideas to more complete designs.

POSSIBLE EXTENSIONS/ALTERNATIVE ADAPTATIONS

There is an optional third-day part of the lesson where students evaluate their own designs and those of others. They use this time to improve their solution.

- Optimize a Solution Extension Activity

This lesson was created by Molly Grace, Mary Lamoreaux, Ken Thornock, and Thomas Wilder.

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