Environmental Education Alliance of Georgia

Zero Waste Heroes

Educator Guide

a curated collection of K-12 activities
to explore ways of reducing waste
from the Environmental Education Alliance of Georgia

Zero Heroes Teacher Guide

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Introduction

The intent of the Zero Heroes lesson collection is to provide opportunities for students to explore the goal of generating "zero waste" from the perspective of various environmental impacts, and to investigate solutions on individual, school-wide and societal levels.

The Zero Heroes lesson collection can be used several ways. Students can investigate an aspect of waste reduction and materials management with lessons that cover a science standard at their grade level. Or all of the lessons can be adapted and taught together in an Environmental Science or Sustainability course.

Zero Heroes goes beyond the "3 Rs" (recycle, reduce, reuse) to consider ways of preventing waste (rethink, reject, refuse) and for dealing with waste (rot, repair, repurpose, recover) through the lens of sustainable living. Students who complete the entire set of lessons will examine systemic problems from fast fashion to food production; assess the roles of individuals, corporations, and societies in contributing to the root causes of excess waste; explore the lifecycles of materials and consumer products, manufacturing, marketing, and packaging; evaluate environmental impacts of waste disposal including disproportionately affected communities; reduce toxicity of waste materials; consider perspectives and needs of various stakeholders; compare recycling to a circular economy; identify ways of bringing attention to the need for change; determine the highest impact ways that students can make a difference in the world; and conserve the planet's natural resources.

Acknowledgments

The Zero Heroes lesson collection was created by Environmental Education Alliance (EEA) the backbone organization for environmental education and outdoor learning in Georgia. EEA envisions a world where every child grows up to be a problem-solver who is connected to nature, knowledgeable about the environment, and empowered to create a more just and sustainable future.

This collection was curated and created with support from Environmental Education North Carolina and their grant from Environmental Protection Agency Region 4. Zero Waste Heroes is a Georgia companion piece to the 'Don't Waste It' project. We are grateful to Lauren Pyle, Executive Director of EENC, for making this project possible.

Standards-alignment

Zero Heroes lessons are compatible with the Georgia Standards of Excellence in Science. The lessons will be useful in states that have adopted Next Generation Science Standards or embraced the Framework for K-12 Science Education and its research-informed "three-dimensional learning". Each lesson provides a phenomenon-based approach which begins with a real-world event that students observe and explore before reading or receiving any information that explains it. Prompted by the question "What do you notice?" students advance a tentative explanation for what they have observed. Then, in response to the question "What do you wonder?" they ask questions that will form the basis for student-directed research. After the research phase, teachers engage students in learning experiences that present new information and insights. Each lesson ends with a chance for students to refine and revise their original explanations to incorporate what they have learned. The essence of "three-dimensional science" is for students to explore before core ideas are explained. For that reason, vocabulary is not memorized in advance, but learned "just in time" – when there is a context and need to understand new words. Standards are listed for each lesson.

Instructional Strategies

Each lesson features one of more of the following three types of learning activities:

Eco-Engineering Challenges

The Eco-Engineering Challenges were created the Environmental Education Alliance (EEA) to engage students in making sense of phenomena and solving problems using design thinking. Each challenge is a STEM learning activity that integrates science, technology, engineering, and math, and contains the following elements:

- an unexplained phenomenon that students observe, ask questions about, and try to explain
- an authentic environmental problem to solve
- a curated collection of research (articles, infographics or other information)
- a design challenge that engages students in making something to help solve the problem (a prototype)
- an opportunity to test and refine the prototype and present it to an audience

To learn more about eco-engineering challenges, consider watching this slide presentation. The teacher activities in the presentation can be explored together by a professional learning cohort.

Community Science Projects

Community Science projects – also called Citizen or Participatory Science - involve students in crowd-sourcing data needed by scientists for authentic ongoing research projects. The data collected may also be useful to students as evidence for their claims about waste-related problems.

Many students report increased self-efficacy and confidence when working on community science projects because they are contributing to something larger than themselves by doing real science that is needed and valued by others. In addition to collecting data and uploading it, some participatory science projects require students to analyze the data, look for trends, construct explanations, or recommend actions. Examples of community science projects include Litterati (students geotag and analyze sources of trash they collect from the ground) and Soil Your Undies (students bury cotton underwear, dig it up 30 days later, and report the extent to which the fabric has biodegraded).

Environmental Stewardship

Several Zero Heroes lessons invite students to design and implement solutions to bite-sized problems in the school or schoolyard. This entails a process of defining and researching a problem; brainstorming solutions; pitching ideas complete with an "elevator speech", budget estimate, and timeline; deciding collectively on a class project; implementing it; presenting the project to an authentic audience; assessing its impact; and reflecting on its value to students.

Offering opportunities for environmental stewardship is important because students often report feeling discouraged and disengaged when learning about environmental problems. Real world problem-solving contributes to feelings of self-determination and inspires civic action.

Field Investigations

Most of the investigations in this lesson collection will take place in the schoolyard. However, some engage students in school-wide observations and data collection, both inside and outside the building. The purposes of the investigations are to identify current practices and procedures, to assess the impacts of those practices, and to better understand a waste-related problem and its potential solutions.

Inclusive Teaching Practices

Teaching about zero waste can incorporate student experiences, cultures, and perspectives by:

- recognizing that each student's culture and experiences result in valuable contributions to class discussions and brainstorming sessions: the greater variety of ideas, the better the brainstorming results
- featuring scientists, inventors, policy makers, and leaders of diverse ages, genders, abilities, races and ethnicities, so every student can imagine themselves in those roles
- analyzing data with tools such as EJ Screen and the EE Landscape Analysis dashboard to identify patterns and connections between where waste is found (locations of landfills, coal ash pits, Superfund sites) and health impacts on nearby communities (https://www.eealliance.org/ee-landscape-analysis.html)
- using curated collections of research articles with the jigsaw protocol, which brings together readers of different abilities in "expert" groups where they analyze the same article, before returning to their "home groups" where each student presents information about a different article. Note: this approach is ideal with the same number of groups as the number of students per group (and number of articles).

Lesson Format for Zero Heroes

Most lessons in the Zero Heroes Teacher Guide are structured in the following way:

Standards The sections of a standard that are addressed by the lesson are highlighted in yellow.

Preparation Obtain materials listed for each lesson and complete advance preparations as noted.

Directions for each lesson or design challenge (on following page) are written for the teacher. Provide students with the appropriate Lab Report from the appendix.

Phenomenon: Present the phenomenon without explanation before or after students observe it (typically: sound off).

What Do you Notice? Engage students in writing about what they observed (or making a labeled drawing) that tells what, who, why and how. This will serve as a tentative explanation, while they are making sense of the phenomenon.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

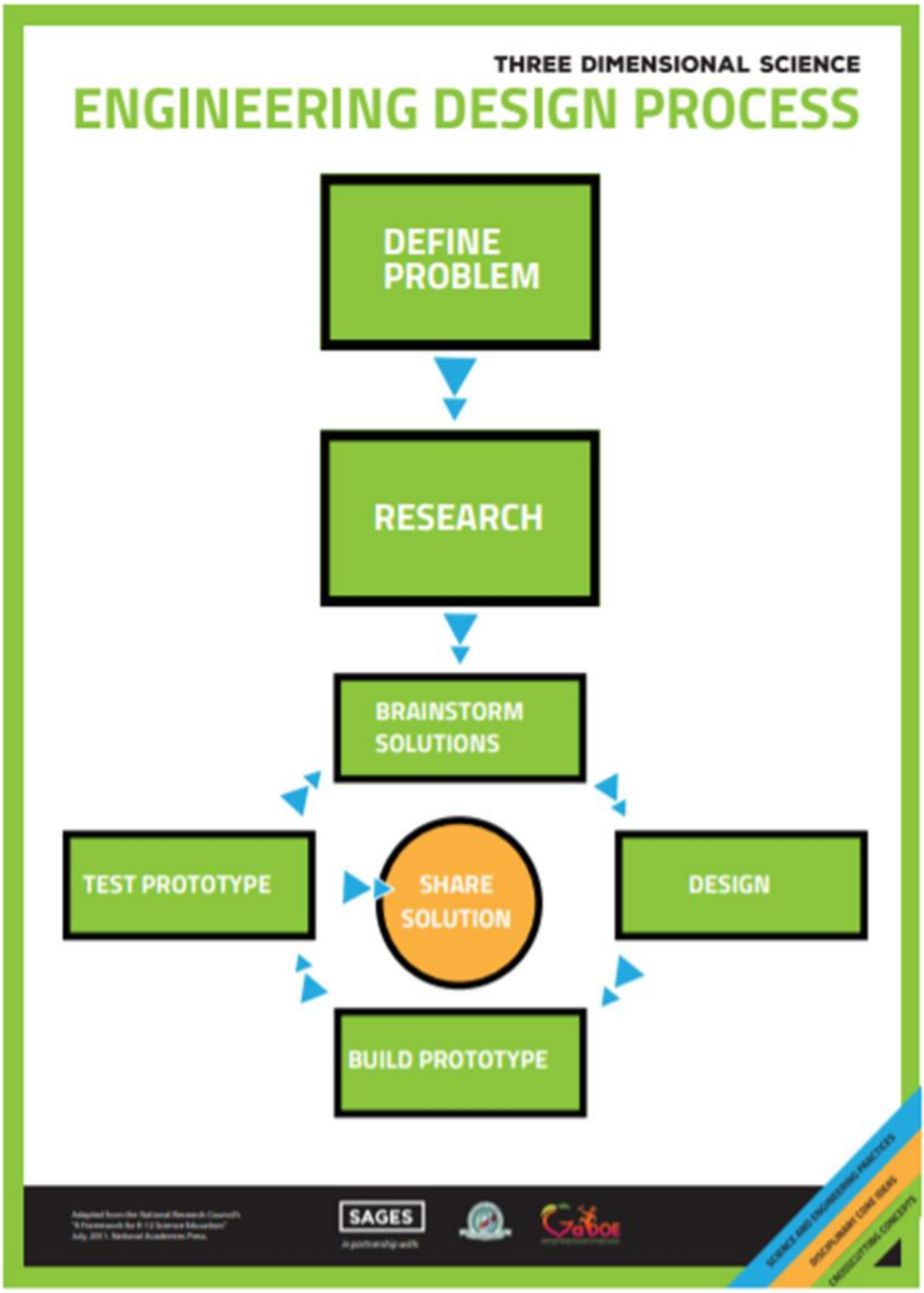
Student Research After students ask their questions, consider placing each question on a sticky note, grouping questions in categories, and grouping students to do research according to their interests. Curated collections of articles are intended to be read and shared using the jigsaw protocol: www.jigsaw.org/ NewsELA is a good source for additional articles, which are available at multiple reading levels. Science Journal for Kids and Science News for Students are vetted sources of articles that can be reviewed and selected in advance for students. More articles are provided than needed.

Teacher-Directed Activity Introduce new knowledge by showing an explainer video or substituting another activity.

Zero Heroes Lesson Activity This lesson provides an Eco-Engineering Challenge, an Environmental Stewardship Project, a Community Science Project, or Field Investigation. The Environmental Education Alliance offers professional learning courses, workshops, and certification to increase teacher capacity for engaging students in these ways.

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon (the What Do You Notice? section). Clear up any student misconceptions about the science standard and how its core idea relates to waste prevention or reduction. A good source of background information - including a video 'crash course' on each standard - can be found at the Wonder of Science (or Bozeman Science) web sites. Note that Georgia standards are not identical to NGSS standards, but both share a "three dimensional" phenomenon-based approach to science education.

Teacher Resources Videos, articles and activities that can be used for Teacher-directed Activities will be found in this section.



Credit: Captain Planet Foundation

Kindergarten – How to Save Critters from Litter: Reuse, Reduce, Rot, Recycle, Refuse!

Standard

K-L2. obtain, evaluate, and communicate information about how organisms and human activity cause changes to the local environment

2a. collaboratively develop and refine a model to represent the relationship between the needs of plants and animals (including humans) and the places they live (Clarification Statement: Students should explore both living and nonliving components in the environment.)

2b. ask questions based on observations to explain how plants and animals (including humans) change the local environment to meet their needs

2c. collaboratively design and communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things to the local environment (Clarification statement: Examples of human impact on the land could include cutting down trees to produce paper and using resources to produce bottles. Examples of solutions include reusing paper and recycling cans and bottles.)

Teaching Tips

Preparation Obtain a variety of items made of different materials for students to bury and dig up 1 week – 1 month later. Consider comparing a food item, fabric item, metal item, plastic item, and paper or cardboard item. Other supplies needed: garden trowels for students to use to dig holes.

Directions for this lesson and investigation (on next page) are written for adult use. Students will use the Notice / Wonder / Design template from the appendix, which has larger space for drawing and writing.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing) that tells what they observed.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for research.

Student Research After each student writes a question, consider placing the question on a sticky note, grouping them in categories, and allowing students to research in small groups according to their interests. A curated collection of videos is provided for student research using the jigsaw protocol: www.jigsaw.org/

Teacher-Directed Activity Show this video to students: What Happens to Stuff We Throw Away? (https://www.youtube.com/watch?v=BjjqkU74lGc) or substitute a similar book or video

Zero Heroes Lesson Activity Students will participate in a schoolyard scavenger hunt to find evidence of ways humans can harm plants or animals by

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon. Clear up any misconceptions about where materials go when they are littered or thrown away.

Teacher Resources

Explainer Videos: choose one or more to show all and the rest for student research groups

Where Does Litter Go? -Sea Animals Harmed by Plastics
What Can We Do to Reduce the Trash we Make? Waste Less Crayon Recycling Reduce, Reuse, Recycle
How Long Does it Take Garbage to Rot Away? Garbage Rotting Away Timelapse
Where does paper come from? Paper is made from trees video
Where do plastic bottles come from? From Oil to Plastics video
Where do cans come from? How Aluminum Cans are Made video

K: How to Save Critters from Litter: Reduce, Reuse, Rot, Recycle, Refuse!

The Phenomenon

Credit: The Dodo – Six Pack Turtle Unstoppable article

What do you notice? (tentative explanation)

*Show the picture of the turtle **without providing any explanation**! Engage students in writing about or drawing what they noticed when observing this phenomenon. Ask them to explain what they think happened. This will serve as their tentative explanation. At the end of the lesson, allow students to revise and refine their explanations to reflect new information and understanding. Explanations may take the form of labeled drawings. Use K-2 Lab Report template. Additional photos of animals harmed by waste may be found here; and plants here.*

What do you wonder? (student questions)

*Engage students in **asking their own questions** about the unexplained phenomenon (misshapen turtle with the plastic loop around its midsection). These questions will form the basis for student research, which the teacher can facilitate by curating the resources below to select the most relevant ones.*

Curated articles and videos for Jigsaw Research www.jigsaw.org

What Happens to Stuff We Throw Away? Where Does Garbage Go?
Where Does Litter Go? -Sea Animals Harmed by Plastics
What Can We Do to Reduce the Trash we Make? Waste Less Crayon Recycling Reduce, Reuse, Recycle
How Long Does it Take Garbage to Rot Away? Garbage Rotting Away Timelapse video
How is paper made? Paper is made from trees video
How is plastic made? From Oil to Plastics video
How are cans made? How Aluminum Cans are Made video

Investigation: Schoolyard Scavenger Hunt

- Conduct a schoolyard scavenger hunt where students search for animals and plants that could be harmed by litter.
    - Also search for litter and collect it to analyze before disposing it properly (in landfill or recycling bin).
    - Note: for the sake of student safety and to reduce the number of disposable gloves needed for this activity, students may be the "spotters" and the teacher the "collector."
    - Categorize the most common types of litter by creating a graph in the classroom.
- Discuss: What harm can waste do? (students may focus on injuries to wildlife, as in phenomenon, or harm to plants and people too).
- Discuss: Ideas for how we can protect wildlife by being less wasteful and recycling, reusing, or refusing disposable items.
- Extension: Participate in the Soil Your Undies community science project by burying different types of materials in the schoolyard.
    - Debrief the activity by asking which items rot if composted; and which do not?
    - Discuss why materials that biodegrade (break down quickly into bits, whether littered or disposed of in a landfill) are less likely to harm wildlife or plants than materials that are long-lasting (do not biodegrade) yet cannot be re-used - such as single-use plastics

Revised Explanation

As a class, discuss and decide on a revised explanation for what happened and why (in the photo that depicts the phenomenon) and what they have learned from it. For instance, students may say they learned that disposing of waste improperly can harm wildlife and that being careful not to litter and choosing to recycle are things people can do to care for the planet, including its plants and animals.

First Grade

Standard

P1-3. Obtain, evaluate, and communicate information to demonstrate the effects of magnets on other magnets and other objects.

3a. Construct an explanation of how magnets are used in everyday life. (GSE S1P2a) (Clarification statement: Everyday life uses could include refrigerator magnets, toys, magnetic latches, and name tags.)

b. Plan and carry out an investigation to demonstrate how magnets attract and repel each other (GSE S1P2b)

c. Plan and carry out the effect of magnets on common objects. (GSE S1P2b)

Teaching Tips

Preparation Obtain Materials listed for lesson and make mixture of paper bits and paper clips for students to sort. Consider placing individual portions of the mix in paper cupcake wrappers for ease of distribution.

Directions for this lesson and design challenge (on next page) are written for adult use. Students will use the Notice / Wonder / Design template from the appendix, which has larger space for drawing and writing.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing) that tells what they observed.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests.

Teacher-Directed Activity Show one or more explainer videos (see Teacher Resources section for ideas).

Zero Heroes Lesson Activity This lesson provides an Eco-Engineering Challenge to design a metal sorter that provides an opening to drop in a mixture of paper bits and paper clips and uses a magnet to separate the metal parts from the paper so each can be recycled separately, without using hands. Before they begin building their metal sorting device, students should be able to see available materials. Then engage them in drawing and labeling a design for the device they will build. After showing the teacher the design, the student or team may begin to build. Provide opportunities to test the device, see what other students have created, and refine or change the design.

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon. Clear up any student misconceptions about magnets and the materials they attract, and why sorting materials by type must happen before like-materials can be recycled together and re-made into another form.

Teacher Resources

Science Buddies Lesson: Teaching Tips for Recycling Sorter Machine
Explainer Videos:

- Magnets in Recycling: https://youtu.be/Th6GQiSHfKk
- How are Magnets Used in Recycling? https://sciencing.com/about-6398727-magnets-used-recycling-.html
- How Do Magnets Help in a Scrapyard? https://www.bbc.co.uk/bitesize/clips/zcntsbk
- Magnets Lifting Metal in a Scrapyard: https://www.youtube.com/watch?v=XBWy9gzGGd4

1st Grade Eco-Engineering Challenge: Junkyard Magnets

The Phenomenon

Video Credit: Steel Unloading with Magnets

What do you notice? (tentative explanation)

Engage students in writing about what they noticed when observing the phenomenon. This will serve as their tentative, initial explanation. At the end of the lesson, allow students to revise and refine their explanations to reflect new information and understanding. Explanations may take the form of labeled drawings. Distribute copies of the K-2 student lab report template in the appendix.

What do you wonder? (student questions)

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student research.

The Eco-Engineering Challenge: Make a Recycling Separator for Metals

Design a device that uses magnets to separate paper clips from paper.
Junkyards contain many kinds of materials that come from old cars. Sometimes metal is separated from other junk using strong magnets. Then the metal can be melted and recycled into new things. See if the device you design can separate paper from metal for recycling. What are other ways things could be separated for recycling?

Constraints

Time Allotted: _____
Design Goals: Design a device with a hole to drop in a mixture of paper and paper clips; the device should use magnets to separate metal from paper; try to make it work so that the paper bits and clips are sorted automatically

Materials

- Metal paper clips
- Paper bits (approx. 1" x .25")
- Magnets
- Scissors
- Cardboard, used file folders, construction paper, empty bathroom tissue or paper towel rolls, small paper cups, used containers
- Paper oil funnels (free from car parts stores) or sheets of paper that can be curled and taped into funnels
- Tape, glue, binder clips, clothespins, or other fasteners

Revised Explanation

Allow students to return to and revise their initial explanations of the phenomenon to reflect what they have learned OR do this as a class discussion.

Second Grade: Transforming Trash

Standard

Obtain, evaluate, and communicate information about the properties of matter and changes that occur in objects.

2-P1a. ask questions to describe and classify different objects according to their physical properties (GSE S2P1a) (Clarification statement: Examples of physical properties could include color, mass, length.)

1b. analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose * [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.]

1c. construct an explanation for how structures made from small pieces (e.g., linking cubes, building blocks) can be disassembled and then rearranged to make new and different structures (GSE S2P1b)

Background

Ideally, students will have already explored properties of matter and changes in matter (GSE S2P1a) before doing this lesson. Directions for this lesson and design challenge are written for adult use. Students may use the K-2 lab report template from the appendix, which has larger space for drawing and writing. Safety Considerations:

- Do not allow students to use iron. Be careful where iron is set up to avoid inadvertent contact.
- Do not allow students to reach into blender or to clean blade assembly.
- Preselect trash and recycling bins from which student may choose trash to remake into paper.

Teaching Tips

Preparation Obtain used white paper (not slick or glossy) from recycling bin or classroom container where it is collected.

Directions for this lesson and design challenge (on next page) are written for adult use. Students will use the K-2 student lab report template from the appendix, which has larger space for drawing and writing. Discuss safety. After the paper dries, allow student to make cards. The inclusion of pressed flowers or flower petals in the paper making process can make this a great tie in with holiday cards, event invitations, pen pal letters or similar occasions.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing) that tells what they observed.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests.

Teacher-Directed Activity Show one or more explainer videos to students from Teacher Resources section below.

Zero Heroes Lesson Activity This lesson is an Eco-Engineering Challenge to make recycled paper from bits of used paper.

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon. Address misconceptions by clarifying that some materials can be disassembled and re-assembled while others cannot. Materials that can be reused (in the same form) or recycled (taken apart and remade) reduce the amount of waste compared to items that are used once and thrown away; and recycling or reusing materials also reduces the amount of natural resources needed to make products for people (such as the number of trees that are cut down to make paper).

Teacher Resources

Boston Children's Museum: Do It Yourself Papermaking for Sustainable Kids (video): https://www.youtube.com/watch?v=wVIyhgZI-X0
Simplest approach to paper-making: Kid Science: Making Paper
Recycled Items that are Broken Down and Remade: https://www.maine.gov/dep/waste/recycle/whatrecyclablesbecome.html
Repurposed Items that are Transformed: https://www.goodnet.org/articles/10-most-amazing-repurposed-items-youll-ever-see-list?
Things that Cannot be Recycled: https://www.bobvila.com/slideshow/20-surprising-things-you-can-t-recycle-52079

2nd Grade Eco-Engineering Challenge: Transforming Trash

The Phenomenon

Building Block Time Lapse Video

What do you Notice? (tentative explanation)

*Engage students in drawing and labeling what they noticed **without** explaining the phenomenon to them (objects can be made from small pieces and disassembled to make into different objects). Their labeled drawings will serve as their tentative explanations. At the end of the lesson, allow students to revise and refine their explanations to reflect new understandings. Use the K-2 student lab report template.*

What do you Wonder? (student questions)

*Engage students in **asking their own questions** about the unexplained phenomenon. These questions will form the basis for student research. Depending on questions asked, these videos may provide some answers: Where Does Paper Come From? and How Recycled Paper is Made;*

Eco-Engineering Challenge: Make Recycled Paper from Bits of Used Paper

Your students' challenge is to make paper from bits of old, used paper. Discussion points: Paper comes from trees that are cut down and ground up into bits. Then the bits are mixed with water and dried to made them into recycled paper. How is making paper like building with blocks? Can we reduce the number of trees that are cut down to make new paper? One way is to use less paper. How could we do that? Another way is to save our old used paper and recycle it into paper again.

Constraints

Time Allotted: _____
Safety considerations for students: No touching iron. No reaching inside blender. Only hold blender button on as long as it takes to count to 3. Supervision required.
Materials: Choose any previously used paper from recycling bin (or trash)

Materials Needed

- Variety of paper / cloth materials: copy paper, paper bags, fabric, scraps
- Dried flower petals (optional). For more info: https://www.ealt.ca/kids-blog/flower-petal-paper
- Scissors to cut paper into small pieces (or tear) less than 1" x 1"
- Plastic dish tubs – 1 small and 1 large (per team)
- Framed screen (such as bacon splatter guard or screen in a picture frame)
- Absorbent towels, rolling pin
- Iron
- Hand or electric blender or food chopper

Revised Explanation

Allow students to return to their original explanation and revise it to show what they have learned.

Third Grade: Food Waste and Vermiculture

Standard

3L-2 Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment. (GSE S3L2)

2a. ask questions to collect information on the different types of pollution (i.e., air, land, and water) and create records of sources and effects of pollution on the plants and animals of Georgia (GSE S3L2a)

2b. construct an explanation to describe the relationship between the types of pollution and the impact of humans on the environment

2c. investigate and communicate solutions, such as conservation of resources and recycling materials, to protect plants and animals of Georgia (GSE S3L2b)

Background

Ideally, students will have conducted a cafeteria "waste audit" before doing this lesson, which can be used as baseline information on the volume of trash going from the school to the landfill. Repeating the audit after the vermiculture project is in place can provide an estimate of the volume of trash diverted from the landfill. For tips on conducting a food waste audit, check out the Cafeteria Culture web site: http://www.cafeteriaculture.org/ School cafeteria trash typically includes uneaten food and a lot of packaging – all of which goes to the landfill. Meanwhile, people are going hungry from lack of food. And the amount of garbage we make is requiring more and larger landfills. Organic (once-alive) waste in a landfill can take years to break down, producing methane gas and leachates when it does. Methane is a powerful greenhouse gas that warms the earth. Leachates leak into the ground can contaminate water.

Teaching Tips

Preparation Obtain red wriggler worms (not night crawlers) from a bait shop, sporting goods or fishing store and refrigerate until needed, making sure holes for air are not blocked. Collect other supplies on the Materials list.

Directions for this lesson and design challenge (on next page) are written for teachers. Provide students with the Eco-Engineering Challenge Lab Report Form from the appendix. Break students into groups of 3-4 for the Challenge.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing) that tells what they observed.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests (worms and food waste). A curated collection of articles is provided for use in small groups, using the Jigsaw protocol. https://www.jigsaw.org/

Teacher-Directed Activity Show one or more explainer videos to students. Encourage the class to contribute to collectively make a rubric for design that incorporates research on worm needs and cafeteria waste.

Zero Heroes Lesson Activity This lesson is an Eco-Engineering Challenge to make worm bins that reduce food waste.

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon. Clear up any misconceptions about worms, vermicompost, landfills, and the differences between vermicompost and compost: https://byjus.com/biology/difference-between-compost-and-vermicompost/

3rd Grade Eco-Engineering Challenge: Solving Food Waste with Vermiculture

The Phenomenon

https://youtu.be/Mxp1nnrUG0Q

What do you notice? (tentative explanation)

Engage students in writing about what they noticed while observing the phenomenon. This will serve as their tentative explanation. At the end of the lesson, allow students to revise and refine their explanations to reflect new information and to tie their understanding to the Eco-Engineering Challenge. Explanations may take the form of labeled drawings.

What do you wonder? (student questions)

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student-directed research in small groups with shared interests.

Eco-Engineering Challenge

Assign this challenge: Design a worm bin that will meet two goals: 1) providing a suitable, healthy habitat for worms based on their needs, and 2) reducing the volume of food waste by converting it to vermicompost.

Constraints

Time: 1 class period for research, design and building; 1 class period for testing and refining prototype and sharing
Specifications: Design must include a suitable habitat for worms and reduce food waste volume
Design must be completed and explained before building starts. Clean Up: work stations

Materials

- red wriggler worms
- shallow waterproof container with lid (such as durable plastic shoebox)
- variety of open-weave materials of different gauges (screen, mesh, netting, filter paper, burlap)
- variety of fasteners (glue, duct tape, binder clips)
- variety of colors of construction paper
- variety of types of cardboard pieces (paperboard, corrugated, etc.), newsprint (uncoated)
- safety glasses, drill
- mister bottles / source of water
- variety of food scraps

Curated Articles for Research Jigsaw (jigsaw.org)

The Habitat of Red Worms (Sciencing.com)
- https://sciencing.com/the-habitat-of-red-worms-13406911.html

Differences between Earth Worms and Compost Worms (Sciencing.com)
- https://sciencing.com/differences-between-earth-worms-and-compost-worms-12498654.html

How to Identify Red Wrigglers at All Stages (ThrivingYard.com)
- https://thrivingyard.com/identifying-red-wiggler-worms/

Vermicomposting 101 (Foodprint.org)
- https://tinyurl.com/ejx9car5

Revised Explanation

Allow students to return to their original explanation and revise it to show what they have learned.

Fourth Grade: Waste Managers in the Wild

Standard

S4L1. Obtain, evaluate, and communicate information about the roles of organisms and the flow of energy within an ecosystem. [GSE S4L1]

a. Develop a model to describe the roles of producers, consumers, and decomposers in a community. (Clarification statement: Students are not expected to identify the different types of consumers – herbivores, carnivores, omnivores and scavengers.) [GSE S4L1a]

b. Develop simple models to illustrate the flow of energy through a food web/food chain beginning with sunlight and including producers, consumers, and decomposers. [GSE S4L1b]

c. Communicate a scenario to demonstrate the effect of a change on an ecosystem. (Clarification statement: Include living and non-living factors in the scenario.) [GSE S4L1c]

d. Use printed and digital data to develop a model illustrating and describing changes to the flow of energy in an ecosystem when plants or animals become scarce, extinct or over-abundant.

Teaching Tips

Preparation Scope out a location for the nature walk, such as a wooded area on campus where rotting logs and leaf litter on the ground create an ideal habitat for decomposers. Alternative: collect rotting logs and the soil immediately beneath them from another location and transport to the schoolyard for students to observe. Print multiples of the 9 decomposer and 1 scavenger photo cards and assign one to each student, who will become the expert on identifying that type of organism and its role.

Directions for this lesson are written for adult use. Students will use the lab report template from the appendix, which has larger space for drawing and writing. Discuss safety.

Phenomenon: Present the phenomenon video without explanation before or after students view it. Play video with sound ***off***.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing) that tells what they observed.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for student research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to research in small groups according to their interests. A curated collection of articles or videos is provided for jigsaw-style research. Each student will summarize an article or video in a small group.

Zero Heroes Lesson Activity This lesson is a Field Investigation that takes place outside in the schoolyard.

Teacher-Directed Activity Conduct a Nature Walk to Look for Signs of Decomposition or Decomposers
Before the walk, consider showing this video https://www.scienceworld.ca/resource/introducing-decomposers/ and assigning students photo cards of decomposers as described in the directions on the next page.

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon. Clear up any misconceptions about how some materials can be disassembled and re-assembled while others cannot.

4th Grade Investigation: Waste Managers in the Wild

The Phenomenon

play from 5:50 - 7:00 with NO sound - Harmony Square videos
https://www.youtube.com/watch?v=JJmSz7PGfcA

What do you Notice? (tentative explanation)

Play the video from 2:19 – 2:30 with no sound. Engage students in writing about what they noticed when observing the phenomenon. This will serve as their tentative, initial explanation. At the end of the lesson, allow students to revise and refine their explanations to reflect wht they have learned. Explanations may take the form of labeled drawings. Distribute copies of the Investigation lab report template in the appendix.

What do you Wonder? (student questions)

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student research. Distribute copies of the student lab report template in the appendix.

Curated Articles and Videos for Research Jigsaw www.jigsaw.org

Articles to be read with students

Recycling the Dead https://www.sciencenewsforstudents.org/article/recycling-dead
Badger Burying a Cow https://www.sciencenewsforstudents.org/article/industrious-badger-caught-burying-entire-cow
Mealworms Chow Down on Plastic https://www.sciencenewsforstudents.org/article/mealworms-chow-down-plastic
Tiny Mighty Food Clean-Up Crews https://www.sciencenewsforstudents.org/article/tiny-mighty-food-cleanup-crews

Videos for Students to watch

Decomposers vs Scavengers https://www.youtube.com/watch?v=qEXW2za_rfA
The Role of Scavengers https://www.nationalgeographic.org/article/role-scavengers-carcass-crunching/7th-grade/
The Value of Vultures https://blog.wcs.org/photo/2021/06/10/the-value-of-vultures-tanzania-africa/
Fungi in the Forest https://www.youtube.com/watch?v=IMWOmCcxUjw

Investigation: Waste Managers in the Wild

Teacher resource to share with class before or after walk: PBS's Decomposers and Scavengers (https://www.pbs.org/video/natureworks-decomposers-and-scavengers/)

Print the 9 decomposer cards that depict "FBI" species and 1 scavenger card; then designate each student an expert on one type. Experts carry their cards outside to consult. When a decomposer or scavenger is noticed, ask students to see if it is "theirs."

- Decomposer Photo Cards https://www.scienceworld.ca/wp-content/uploads/attachments/resources/Decomposers%20Cards.pdf
- All About Birds: Turkey Vultures https://www.allaboutbirds.org/guide/Turkey_Vulture/id

Take the class on a "scavenger hunt" nature walk to look for decomposers and scavengers. Use field microscopes or bring rotting log or soil specimens back to class to view under a microscope and look for bacteria.

Revised Explanation

Allow students to return to and revise their initial explanations of the phenomenon. Clear up any misconceptions about the size or function of fungi, bacteria, invertebrates, and scavengers. Prompt students to tell what the world would be like without any scavengers or decomposers to consume dead plants and animals. How are decomposers "waste managers"? What types of waste may they not be able to break down into soil?

Fifth Grade: Mighty Microbes

Standard

5L4. Obtain, evaluate, and communicate information about how microorganisms benefit or harm larger organisms (Clarification statement: Possible microorganisms could include Tardigrades, Lactobacillus, Probiotics, Rotifers, Salmonella, Clostridium botulinum (Botox), E-coli, Algae, etc. Students are not expected to know these specific microorganisms. The list is provided to give teachers examples.)

4a. Construct an argument using scientific evidence to support a claim that microorganisms are beneficial.

4b. Construct an argument using scientific evidence to support a claim that microorganisms are harmful.

Teaching Tips

Preparation Note that the community science project included in this lesson requires 60 days from start to finish.

Directions for this lesson and design challenge (on next page) are written for adult use. Students will use the student lab report template from the appendix.

Phenomenon: Present the phenomenon video without explanation. Play video with sound ***off***.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing) that tells what they observed (what is happening and how or why it occurred).

What Do you Wonder? Engage students in asking their own questions, which will form the basis for student research.

Student Research Consider placing each student question on a sticky note, grouping the questions in categories, and allowing students to research in small groups according to their interests. A curated collection of articles or videos is provided for research purposes using a jigsaw classroom approach in small groups, equal in number of members to the number of articles.

Teacher-Directed Activity Provide supplies to each small group. Take students to the schoolyard to scope out areas with different soils, so they can select places where they will plant cotton underwear horizontally, 3" deep. Students will measure the weight and dimensions of the underwear before burying it, documenting the process with photos and maps. Prompt students to make claims about what will happen to the underwear while buried and how microorganisms affect the process. ***Keep the initial claims and data!*** Dig up underwear and compare 60 days later. Use a microscope to observe microorganisms, if possible. Address any misconceptions about the role of microorganisms in decomposition by clarifying that bacteria are not just sortable into "good" and "bad" species. The same microorganism can have both beneficial and harmful effects on humans. For instance, bacteria that cause food spoilage and make people sick if they eat the food, but are also providing a 'service' by digesting and removing dead and decaying organisms from the environment, which helps people.

Revised Explanation Allow students to revise their initial explanations of the phenomena of the pumpkin and undies. After digging up the underwear, students will measure and weigh it to compare before and after data.
Provide this prompt for students to write a C-E-R (Claim – Evidence – Reasoning) argument:

- Claim: Restate your original claim describing the pumpkin and predicting what will happen to the underwear while buried.
- Evidence: Analyze before and after data to describe the change in the underwear as observed and measured. Tell whether the data provides evidence of the role of microorganisms in the decomposition process.
- Reasoning: Use the law of conservation of matter as the reasoning that connects the data to the claim. The law of conservation of matter says that matter is neither created nor destroyed; however, it can change forms.
- Revised Claim: If the evidence does not support the claim, revise the claim. Identify an impact on humans caused by microorganisms involved in the decomposition process.

Suggested CER Prompt: My initial claim was that _____ would happen to the underwear when it was buried, which is an indicator of [beneficial / harmful / no] action by microorganisms. When we dug it up, the underwear had [changed / not changed], as evidenced by my observation that: _____ and by this before and after data: _____. Because we know that matter is neither created nor destroyed but can change forms (law of conservation of matter) I conclude that this happened:_____ which (supports / does not support) my original claim. The role of microorganisms in this process was [beneficial to humans; harmful to humans; neither, or both].

Extension Students may investigate crime-solving based on the predictable progression of a human body through decay and decomposition stages. Solving Crimes with the Necrobiome (sensitive content/ preview before using)

5th Grade Community Science Project: Mighty Microbes

The Phenomenon

Decaying Pumpkin credit: James Knot
https://www.youtube.com/watch?v=0ReYKu__luA

What do you Notice? (tentative explanation)

Engage students in writing about what they noticed when observing the phenomenon. This will serve as their initial claim for a C-E-R (Claim - Evidence - Reasoning) argument. At the end of the lesson, allow students to use the C-E-R prompt (provided on the previous page) to revise and refine explanations so that they reflect the evidence gathered before and after the Undies challenge, and interpret evidence using reasoning based on knowledge of scientific principles.

What do you Wonder? (student questions)

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student research. Distribute copies of the student lab report template in the appendix.

Curated Articles for Research Jigsaw www.jigsaw.org

- Recycling the Dead Science News for Students; Kathiann Kowalski; September 27, 2014
  https://www.sciencenewsforstudents.org/article/recycling-dead
- Healthy Soils are Black Gold; Science News for Students; Catherine Arnold; February 25, 2021
  https://www.sciencenewsforstudents.org/article/healthy-soils-life-giving-black-gold-ecosystem-agriculture
- Bacteria All Around Us; Science News for Students; Lindsey Conkle; October 4, 2018
  https://www.sciencenewsforstudents.org/article/bacteria-are-all-around-us-and-thats-okay
- Biodegradation; KidzSearch Safe Wiki
  https://wiki.kidzsearch.com/wiki/Biodegradation
- Decomposition: What Happens When Living Things Die?; TheK8School
  https://k8schoollessons.com/decomposition-what-happens-when-living-things-die/
- The Soil Food Web infographic; JessicasGarden.net
  https://jessicasgarden.net/wp-content/uploads//2011/02/soil-ffod-web.jpg
- What Happens in a Landfill?
  https://www.crd.bc.ca/docs/default-source/Partnerships-PDF/what-happens-in-a-landfill-.pdf?sfvrsn=ac1088c9_0#:~:text=Waste%20decomposes%20in%20a%20landfill,%2C%20temperature%2C%20and%20moisture%20available.
- The Myth of Biodegradation in Landfills; EcoProducts
  https://www.ecoproducts.com/images/pdfs/talking_points/Biodegradation.pdf

Community Science Project

The Soil Your Undies Challenge

Choose locations with different soils. Weigh and measure cotton underwear. Take photos before before burying it. Plant underwear 3" deep, horizontally. Mark spots. Wait 60 days. Dig up undies. Compare the size and weight. Use this form to report data and Track. Draw conclusions about the role of microorganisms.

Materials

- Cotton underwear (1 per group)
- Shovel or trowels (1 per group)
- Digital scale (0 - 2oz or 55g)
- Measuring tape (1 per group)
- Phone or camera to take pics
- Microscope to observe microorganisms

Revised or Refined Explanation

Prompt students to make a claim about the decomposition of buried cotton underwear and the pumpkin; to provide evidence (including data); and to explain their reasoning to connect the evidence to the claim. (See previous page).

Sixth Grade: Innovations and Inventions

Standard

6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.

6a. Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives.

6b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air.

6c. Construct an argument evaluating contributions to a rise in global temperatures over the past century. (Clarification statement: Tables, graphs, and maps of global and regional temperatures, and atmospheric levels of greenhouse gases such as carbon dioxide and methane, should be used as sources of evidence.)

Teaching Tips

Preparation Collect a variety of used items for creative re-use. There is no particular Materials list.

Directions for this lesson and design challenge (on next page) are written for teachers. Provide students with the Eco-Engineering Challenge Lab Report Form from the appendix. Break students into groups of 3-4 for the Challenge.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing) that tells what they observed.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests. A curated collection of articles is provided for use in small groups, using the Jigsaw protocol. https://www.jigsaw.org/

Teacher-Directed Activity Engage students in this PBS Lesson Plan: How Student Inventors Can Solve the Earth's Plastic Problems, showing its 6 minute video explaining plastic life cycle as well as the 9.5 minute video evaluating the limited effectiveness of recycling plastics. Then share the Fast Company article about 10 clever student inventors, for inspiration. Frame the eco-engineering challenge as an invention or an innovation (a change in practice or new way of doing something that does not necessarily require invention). Break the class into teams of 3-4 for the Challenge. https://www.pbs.org/newshour/extra/lessons-plans/lesson-plan-how-student-inventors-can-help-solve-the-earths-plastic-problem/ This is the article included in the lesson: Clever Student Inventions that Reduce Waste https://www.fastcompany.com/3060571/10-clever-student-inventions-that-could-reduce-our-waste

Zero Heroes Lesson Activity This is an Eco-Engineering Challenge to innovate or invent a way to reduce plastic waste.

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon. Clear up any misconceptions about plastics (students should know they are made from fossil fuels), the problem single-use plastics present, excess packaging, the limitations of plastic recycling (downgraded quality and types that cannot be recycled).

6th Grade Eco-Engineering Challenge: Innovating to Reduce Waste

The Phenomenon

credit: Plastic Pollution Coalition

What do you notice? (tentative explanation)

Show the image and engage students in writing about what they notice. This will serve as their tentative, initial explanation. At the end of the lesson, allow students to revise and refine their explanations to reflect wht they have learned. Explanations may take the form of labeled drawings. Distribute copies of the Investigation lab report template in the appendix.

What do you wonder? (student questions)

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student research. Use copies of the student lab report template in the appendix.

Curated Articles for Research Jigsaw www.jigsaw.org

Boyan Slat Cleaning the World's Oceans video
https://www.youtube.com/watch?v=hdZxYQmu8kE
Genius Inventions to Stop Us from Using So Much Plastic
https://www.usatoday.com/story/money/2019/06/17/19-genius-inventions-that-can-stop-us-from-using-so-much-plastic/39358833/
Earth Force Sustainability Challenge
https://earthforce.org/csc/
Lynne Cherry's Young Voices for the Planet
https://www.youngvoicesfortheplanet.com/

Eco-Engineering Challenge: Prevent, Reduce or Remove Plastic/Packaging Waste

Students have invented some of the most effective ways to reduce waste by preventing it, cleaning it up, or providing durable alternatives to single-use items. Wasteful packaging, harmful pollution, and persistent materials that don't decompose are some of the problems. Read about some inspiring innovations, identify a problem, and design a solution. Build and test a prototype (or a small-scale model, if needed) to find out how effective your idea could be. Refine the design based on the test.

Constraints

Time Allotted: _____
Materials: Students should find and use recycled, repurposed or biodegradable materials for their project.

Materials Needed (will vary by project)

Collection of used, recycled, repurposed or biodegradable materials such as paper, fabric, foil, contaainers
Tools: Scissors, pliers, drill and bits (if available)
Fasteners: tapes, glue, clips
Structural elements: used wire hangers, dowel rods, corrugated cardboard

Revised Explanation

Allow students to return to and revise their initial explanations of the phenomenon.

Seventh Grade: Native Bee Habitat and Nesting Spaces

Standard

S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.

a. Construct an explanation for the patterns of interactions observed in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem. (Clarification: The interactions include, but are not limited to, predator-prey, competition, mutualism, parasitism, commensalism.)

b. Develop a model to describe the cycling of matter and the flow of energy among biotic and abiotic components of an ecosystem. (Clarification statement: Emphasis is on tracing movement of matter and flow of energy, not the biochemical mechanisms of photosynthesis and cellular respiration.)

c. Analyze and interpret data to provide evidence for how resource availability, disease, climate, and human activity affect individual organisms, populations, communities, and ecosystems.

d. Ask questions to gather and synthesize information from multiple sources to differentiate between Earth's major terrestrial biomes (i.e., tropical rain forest, savanna, temperate forest, desert, grassland, taiga, tundra) and aquatic ecosystems (i.e., freshwater, estuaries, and marine).

Background

Students will upcycle waste materials to create native bee habitats. Upcycling reuses, recombines, or repurposes waste materials in recognizable forms rather than breaking down and forming new materials, as recycling does. Consider background information about reasons for native bee decline such as Pollinators in Peril by the Center for Biological Diversity. https://www.biologicaldiversity.org/campaigns/native_pollinators/pdfs/Pollinators_in_Peril.pdf or consult the National Native Bee Inventory and Monitoring Program for possible solutions: https://www.usgs.gov/centers/eesc/science/native-bee-inventory-and-monitoring-lab

Teaching Tips

Preparation Obtain used, clean containers and hollow stems or similar items (paper straws, sheets of paper that can be rolled into artificial stems, drill for making holes in wood, etc.) Collect other supplies on the Materials list.

Directions for this lesson and design challenge (on next page) are written for teachers. Provide students with the Eco-Engineering Challenge Lab Report Form from the appendix. Break students into groups of 3-4 for the Challenge.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing a tentative explanation (or making a labeled drawing)

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests (worms and food waste). A curated collection of articles is provided for use in small groups, using the Jigsaw protocol. https://www.jigsaw.org/

Teacher-Directed Activity Show one or more explainer videos to students such as Monga Bay's "Solitary Bees" film: https://youtu.be/G6_xXQk6o28. Encourage the class to collectively make a rubric for evaluation of their bee habitats and nesting spaces.

Zero Heroes Lesson Activity This lesson is an Eco-Engineering Challenge to make native bee nesting spaces.

Revised Explanation Allow students to return to and revise their initial explanations of the phenomenon. Clear up any misconceptions about native solitary bees vs non-native honey bees that live in hives. Encourage students to provide examples of how the following factors affect bee populations: resource availability, disease, climate, and human activity in terms of effect on individual organisms, populations, communities, and ecosystems.

Extension Students may restore native bee habitat by planting appropriate nectar and hollow stem plants for nesting. The Data Nuggets activity: "To Bee or Not to Bee Aggressive" allows students to interpret data to determine whether aggression contributes to survival: https://datanuggets.org/2017/06/bee-aggressive/ and "Do Insects Prefer Local Foods?" explores the impact of non-native species: http://datanuggets.org/2014/01/do-insects-prefer-local-or-foreign-foods/

Eco-Engineering Challenge: Build an Air Bee 'n Bee

The Phenomenon

What do you notice? (tentative explanation)

Show the image and engage students in writing about what they notice. This will serve as their tentative, initial explanation. At the end of the lesson, allow students to revise and refine their explanations to reflect what they have learned. Explanations may take the form of labeled drawings. Distribute copies of the Eco-Engineering Challenge lab report template in the appendix.

What do you wonder? (student questions)

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student research. Use copies of the student lab report template in the appendix.

Curated Articles on Bees' Needs for Research Jigsaw www.jigsaw.org

Are Honey Bees Native? by USGS
https://www.usgs.gov/faqs/are-honey-bees-native-north-america#news
What is the Role of Native Honeybees in the US?
https://www.usgs.gov/faqs/what-role-native-bees-united-states
The Bee n Bee in Your Garden or How to Help Solitary Bees by Urban Pollinator Project: N Mitschunas
http://urbanpollinators.blogspot.com/2012/08/the-bee-bee-in-your-garden-or-how-to.html
Kids Abuzz to Save Bees by Washington Post adapted by Newsela
https://newsela.com/read/kids-save-bees/id/2001011316/
Insect Hotels: Refuge or Fad?
https://entomologistlounge.wordpress.com/2017/09/18/insect-hotels-a-refuge-or-a-fad/?
Creating Pollinator Nesting Boxes to Help Native Bees by UGA Extension
https://extension.uga.edu/publications/detail.html?number=C1125&title=Creating+Pollinator+Nesting+Boxes+to+Help+Native+Bees
The Horrors of Mass-Produced Bee Houses by Colin Purrington
https://colinpurrington.com/2019/05/horrors-of-mass-produced-bee-houses/
Guide to Building a Mason Bee House by Colin Purrington
https://colinpurrington.com/2019/05/guide-to-diy-mason-bee-houses/

Eco-Engineering Challenge: Restore or Create Habitat for Native Solitary Bees

Native solitary bees are in decline due to lack of nesting spaces, resulting from loss of plants and habitat fragmentation. Design a way to create nest spaces or to restore habitat that meets the needs of native bees, according to your research.

Constraints

Time Allotted: _____
Materials: Students must upcycle or reuse waste materials to create healthy habitats or nesting spaces for native, solitary bees. For clarification of upcycling (reusing waste materials in existing form) vs recycling (breaking down waste materials to form new materials) see this article: https://www.diversitech-global.com/post/recycling-vs-upcycling

Materials Needed

- Waterproof container such as clean, used soup or coffee can; glass jar; metal container; wooden box; or solid piece of wood
- Hollow stems or similar items such as paper straws, rolled paper, cylindrical pasta, reeds, wood drilled with holes, etc.
- String or other materials to mount or fasten nesting space or habitat in an appropriate location for bees
- Tape for fastening rolled paper into artificial stems
- Drill, bits, safety glasses, and power source for making hollow spaces in solid blocks of wood (optional)

Revised Explanation

Allow students to return to and revise their initial explanations of the phenomenon.

High School Physical Science: Nuclear Waste Disposal Dilemma

Standard

PS4. Obtain, evaluate, and communicate information to explain the changes in nuclear structure as a result of fission, fusion and radioactive decay.

4a. Develop a model that illustrates how the nucleus changes as a result of fission and fusion.

4b. Use mathematics and computational thinking to explain the process of half-life as it relates to radioactive decay. (Clarification statement: Limited to calculations that include whole half-lives.)

4c. Construct arguments based on evidence about the applications, benefits, and problems of nuclear energy as an alternative energy source.

Background

Here is good background info for teachers on how radioactive decay is a random process that can be predicted in a way that is closely aligned to the actual decay sequence. https://www.youtube.com/watch?v=HRwey6cwGHo

Teaching Tips

Preparation Students will need internet connected devices for the simulation and research.

Directions for this lesson are written for teachers. Provide students with the Investigation Lab Report from appendix.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing an explanation (or labeled drawing) that tells what, why, how.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests. A curated collection of articles is provided for use in small groups, using the Jigsaw protocol. https://www.jigsaw.org/

Teacher-Directed Activity Discuss this article with the whole class: How Stuff Works: How Nuclear Power Works https://science.howstuffworks.com/nuclear-power.htm Clear up a common misconception about nuclear power: that it generates electricity in a novel way. In fact, energy given off by enriched uranium (U-238) simply heats water into steam. Then the steam is used to turn a turbine that generates electricity, just as with coal, wind, or hydropower. However, since no fossil fuels are burned to create the steam, generation of nuclear power does not emit greenhouse gases that contribute to climate change (although the mining and transportation of U-235 may use fossil fuels).

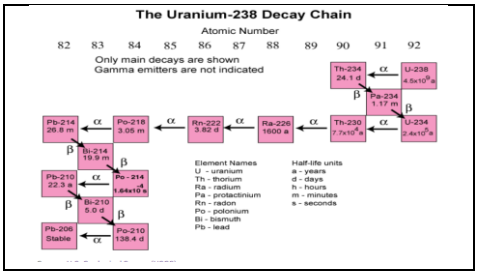
Zero Heroes Lesson Activity Engage students in the nuclear power generation simulation and in calculating the half-life of spent U-238 nuclear fuel rods. Students will make and defend a claim about nuclear waste disposal.

Revised Explanation Allow students to revise their initial explanations of the phenomenon, reflecting what they have learned. Provide these prompts for students to write a C-E-R (Claim – Evidence – Reasoning) argument:

- Claim: State your claim regarding whether the merits of nuclear power outweigh nuclear waste disposal issues.
- Evidence: Provide evidence *including data regarding the half-life of nuclear waste* to identify related issues.
- Reasoning: Use the law of conservation of matter as the reasoning that connects the data to the claim. This scientific principle says that matter is neither created nor destroyed, but can change forms. As uranium throws off alpha, beta and gamma rays in the process of decaying from one element to another, the U238 decay chain progresses toward stable lead over a period of time revealed by the half-life.
- Revised Claim: If the evidence does not support the original claim, revise the claim. Identify major benefits and risks presented by nuclear power and draw a conclusion about the relative merits of this power source.

Physical Science - Investigation: Nuclear Waste Disposal

The Phenomenon



What do you notice? (tentative explanation)

Engage students in writing about what they noticed when observing the phenomenon. This will serve as their tentative, initial explanation. At the end of the lesson, allow students to revise and refine their explanations to reflect new information and understanding. Explanations may take the form of labeled drawings. Make an initial claim about whether nuclear waste disposal issues outweigh the value of nuclear energy.
Phenomenon image: https://www.epa.gov/radiation/radioactive-decay

What do you Wonder? (student questions)

Engage students in asking their questions about the phenomenon. The questions will form the basis for student research.

Curated Articles for Research Jigsaw www.jigsaw.org/

Nuclear Waste Transportation Issues
www.ucsusa.org/resources/safer-storage-nuclear-waste or www.epa.gov/radtown/transportation-radioactive-material
EIA: Nuclear Power and the Environment
https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php
CK12 Nuclear Waste Disposal
https://app.kiddom.co/search/content/6795/nuclear-waste-disposal?q=HS-PS1-8
CalAcademy- Nuclear Energy: What's Your Reaction
https://www.calacademy.org/educators/lesson-plans/nuclear-energy-whats-your-reaction
Radioactive Waste Facts for Kids
https://kids.kiddle.co/Radioactive_waste
How Stuff Works: Nuclear Waste Disposal
https://science.howstuffworks.com/environmental/green-science/reducing-solid-waste.htm
Lumen Nuclear Chemistry for Non-Majors: Half-Life – We're Putting it Where?
https://courses.lumenlearning.com/cheminter/chapter/half-life/
Rethinking Nuclear Energy https://youtu.be/poPLSgbSO6k
Curious Kids - Why Does the World Store Nuclear Waste Instead of Shooting It Into the Sun? https://theconversation.com/curious-kids-why-does-the-world-store-nuclear-waste-and-not-just-shoot-it-into-the-sun-or-deep-space-108675

Investigation – Nuclear Power Generation and the Half Life of U238 Wsste

Manage a nuclear plant with this simulation:

- Idaho Public Television- Nuclear Power Plant Simulator Game http://www.nuclearpowersimulator.com/#Start

Calculate the Half-Life of Spent Nuclear Rods https://sciencing.com/calculate-half-life-equations-8519366.html

Revised or Refined Explanation

Make a **claim** about whether nuclear waste disposal issues present risks that are significant enough to outweigh the benefits of nuclear power, using the law of conservation of mass as the scientific principle that provides the **reasoning** that connects the **evidence** (data on the U238 decay chain and the half-life of spent fuel rods) to the **claim**.

Suggested Format: My claim was that nuclear power is _____ relative to the risks presented by nuclear waste disposal issues. When U238 nuclear fuel rods are spent, they change in this way: _____, as evidenced by this data: _____. Because we know that matter is neither created nor destroyed but can change forms (law of conservation of matter) we can conclude that the data means this about the disposal of nuclear waste:_____ This (supports / does not support) my original claim. Other factors that should be considered include: _____. Knowing what I know now, I (would / would not) change my claim because _____.

High School Biology: Litter & Landfills

Standard

SB5. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

a. Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems. (Clarification statement: Factors include population size, carrying capacity, response to limiting factors, and keystone species.)

b. Develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.

- Arranging components of a food web according to energy flow.
- Comparing the quantity of energy in the steps of an energy pyramid.
- Explaining the need for cycling of major biochemical elements (C, O, N, P, and H).

c. Construct an argument to predict the impact of environmental change on the stability of an ecosystem.

d. Design a solution to reduce the impact of a human activity on the environment. (Clarification statement: Human activities may include chemical use, natural resources consumption, introduction of non-native species, greenhouse gas production.)

e. Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).

Teaching Tips

Preparation Provide gloves, sorting containers (boxes), trash bags (biodegradable preferred). Students will need cameras or cell phones with camera function and the Litterati app. Optional: engage students in an eco-engineering challenge to build garbage grabbers that help students collect trash without touching it.

Directions for this lesson are written for teachers. Provide students with the Community Science Lab Report from the appendix. Break students into groups of 3-4 for the Community Science Project.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing a tentative explanation (or labeled drawing) that tells what, why, how.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests. A curated collection of articles is provided for use in small groups, using the Jigsaw protocol. https://www.jigsaw.org/

Teacher-Directed Activity Direct students to graph or chart data from the Litterati project and analyze the results. Prompt students to consider these tips and ideas from Global Stewards: http://www.globalstewards.org/ecotips.htm Then engage students in designing and conducting a project to prevent or reduce waste, based on their findings.

Zero Heroes Lesson Activity This is a Community Science Project to collect data on sources of litter in the schoolyard. An analysis of students' Litterati data, as well as open data from a wider impact area (https://opendata.litterati.org/) can help define the problem and consider the most effective project they could organize to prevent or reduce litter.

Revised Explanation Allow students to revise their initial explanations of the phenomenon, reflecting what they have learned. Clear up misconceptions about the topic. Engage students in discussion of solutions at individual, corporate, and societal levels. Let students choose, design, implement, and assess a project to contribute to a solution.

Teacher Resources

Additional lesson resources can be found in the education part of the Litterati app: https://edu.litterati.org/

Biology - Community Science Project: Litter & Landfills

The Phenomenon

What do you notice? (tentative explanation)

Engage students in observing the phenomenon. What do you notice? Students will write a tentative explanation that includes who / what / why / and how the phenomenon occurs.

What do you wonder? (student questions)

Engage students in asking questions about the phenomenon. These questions will provide the basis for their research.

Curated Resources for Jigsaw Research www.jigsaw.org/

The Problems

Let 'em Litter? What is the Right Role for Individuals? Barash, David; Psychology Today; December 2, 2019
https://www.psychologytoday.com/us/blog/pura-vida/201912/letem-litter-what-is-the-right-role-individuals
Doing Well by Doing Good; Roper, Stewart; Journal of Business Research Volume 66, Issue 11, November 2013, Pages 2262-2268
https://www.sciencedirect.com/science/article/pii/S0148296312000501
The Litter Myth (podcast); Throughline on National Public Radio, September 5, 2019 https://www.npr.org/2019/09/04/757539617/the-litter-myth
Malaysia Sending Back Plastic Waste to Foreign Countries ; NewsELA adaptation from Associated Press, June 11, 2019
https://newsela.com/read/malaysia-plastic-waste/id/52546
Catastrophic Effects of Littering on Wildlife https://www.conserve-energy-future.com/littering-effects-humans-animals-environment.php
Animals Stuck in Plastic https://www.plasticsoupfoundation.org/en/plastic-problem/plastic-affect-animals/animal-stuck-plastic/

The Proposed Solutions

Keep America Beautiful Being a Good Neighbor: A Guide to Reducing Litter, Managing Trash, and Encouraging Recycling
https://kab.org/wp-content/uploads/2017/10/BeingaGoodNeighor_AGuidetoReducingLitterManagingTrashandEncouragingRecycling.pdf
Made in GA from Recycled Content https://www.youtube.com/watch?v=mZPgiICfsx4
Eco-Friendly Marketing Guide from the FTC https://www.consumer.ftc.gov/articles/eco-friendly-and-green-marketing-claims
Recycling Basics from EPA https://www.epa.gov/recycle/recycling-basics
Things that can be made out of recycled items https://www.globalcitizen.org/en/content/recycled-plastic-10-cool-products/
What if We Could Put Plastic Trash to Good Use? NewsELA, PBS NewsHour; October 5, 2018 https://newsela.com/read/plastic-pollution-solutions/id/46367/
Additional: NewsELA Lisa Koch's articles on Trash https://newsela.com/text-sets/159432/kochanthropologytrash

The Community Science Project: Litterati https://litterati.org/

Download the Litterati app.
Choose a schoolyard or RiversAlive site.
Collect litter and discarded items.
Photograph and tag each piece of litter.
Sort litter for recycling and landfill.
Dispose of litter properly.
Upload tagged litter pics.
Analyze data re: types, sources of litter.
Litterati tutorial videos; Litterati FAQs; Litterati impact stories.

Analyze your litter data and that of the larger impact area (https://opendata.litterati.org/) in terms of sources.
Consider how trash originating on land ends up in the ocean, using RiverRunner (https://river-runner.samlearner.com/) to follow the path of rain that flows cross ground as runoff.
Explore how TerraCycle (https://www.terracycle.com/en-US/) could provide a solution for hard-to-recycle items.
Discuss Keep America Beautiful's goal for "each person in America… to pick up 152 pieces of litter to make our nation… litter-free" and decide whether it is n appropriate goal.

Revised Explanation

Allow students to return to their original explanation of the phenomenon and revise it to include what they learned. Prompt students to analyze the impact of litter on an ecosystem and propose the most effective project students could do at school to prevent or reduce litter and waste. Provide them an opportunity to follow through on their project idea(s).

High School Environmental Science: Ocean Plastics

Standard

EV4. Obtain, evaluate, and communicate information to analyze human impact on natural resources.

4a. Construct and revise a claim based on evidence on the effects of human activities on natural resources.

Human Activities: Agriculture, Forestry, Ranching, Mining, Urbanization, Fishing, Water use, Pollution, Desalination, Wastewater treatment

Natural Resources: Land, Water, Air, Organisms

4b. Design, evaluate, and refine solutions to reduce human impact on the environment including, but not limited to, smog, ozone depletion, urbanization, and ocean acidification.

4c. Construct an argument to evaluate how human population growth affects food demand and food supply (GMOs, monocultures, desertification, Green Revolution).

Teaching Tips

Preparation Students will need internet connected devices. Request the free Ocean Debris Investigation Kit from Algalita (https://algalita.org/educators/) with Student Workbook (https://drive.google.com/file/d/1mx2KK9s3U9fqUuJptlLEAZ2cEHF9XZmA/view) or obtain materials for the alternative teacher-directed investigations below, including (for 1) small rubber ducks or paper images of rubber ducks, world map centered on the Pacific, (for 2) water sample with tiny bits of plastic debris, containers such as glass jars for float tests, array of plastic trash items to test, printed animal profile cards, (for 3) coffee filters, cleanser containing microplastics, jars or containers

Directions for this lesson are written for teachers. Provide students with the Investigation Lab Report from appendix.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it. Keep sound off.

What Do you Notice? Engage students in writing an explanation (or labeled drawing) that tells who, what, why, how.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests. A curated collection of articles is provided for use in small groups, using the Jigsaw protocol. https://www.jigsaw.org/

Teacher-Directed Activity Engage students in rotating among these four investigation stations:

1. Students design an investigation to see what plastic items will Sink or Float . Address why it matters with this investigation:
    - Water Column Cross Section, Animal Profile Cards, Density Table , Monterrey Bay Water Column Investigation
2. Students design an investigation to track the path of floating debris, based on the Friendly Floaties or Rubber Duckie Lab
    - Analyze results of the investigation using this Map of ocean currents
3. Identify components of "plastic soup" from the "Great Pacific Garbage Patch" using this Guide to Recognizing Microplastics
    - Then design a protocol for Microplastic extraction based on this video and investigation

Zero Heroes Lesson Activity Students will design and carry out an environmental stewardship project to engage fellow students and school staff in making systemic or personal changes that reduce plastic waste or prevent plastic use

Revised Explanation Allow students to revise their initial explanations of the phenomenon, reflecting what they have learned and the effectiveness of their project(s). Identify how they would refine the project to improve effectiveness.

Teacher Resources Share any of the following for project inspiration:

GREAT Projects Ocean Planner *https://docs.google.com/document/d/1uvDCsMEJKMnP5WGodCsNMt5FeuWkEru5AT0Dzcasx4k/copy*

Plastic Prevention Projects: Plastic Pollution Coalition Guide https://www.plasticpollutioncoalition.org/get-involved#guides

Clean Up Projects Babylegs microplastics catcher, SeaBin project, Mr Trash Wheel, Boyan Slat's *Ocean Cleanup*

Environmental Science: Ocean Plastics Environmental Stewardship Project

Phenomenon	What Do You Notice? (tentative explanation)
 ***Credit: Chris Jordan – Midway: Message from the Gyre*** ***http://www.chrisjordan.com/gallery/midway-film/#trailer*** ***https://vimeo.com/218502282***	*Play video without sound to present the phenomenon. Engage students in writing (or creating a labeled diagram) about what they noticed while observing the phenomenon including who, what, why, where, and how they think it occurs. This will serve as a tentative explanation while they are doing research and conducting investigations to make sense of this.*

What do you Wonder? (student questions)

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student research.

Curated Articles for Research Jigsaw www.jigsaaw.org/

Boyan Slat's Ocean CleanUp Project
https://theoceancleanup.com/oceans/
Ocean Debris from Land-based Sources infographic
https://www.ecowatch.com/80-of-ocean-plastic-comes-from-land-based-sources-new-report-finds-1891173457.html
What Happens to Marine Plastics infographic
https://green-alliance.org.uk/marine_plastics_graphics_references.php.php
Marine Debris
https://marinedebris.noaa.gov/images/plastics-ocean-infographic
Great Pacific Garbage Patch infographic
https://visual.ly/community/Infographics/environment/great-pacific-garbage-patch
Wandering Albatross - characteristics and behavior
https://oceanconservancy.org/wildlife-factsheet/laysan-albatross/
Tracking Recycling to Reveal Where it Really Goes
https://www.youtube.com/watch?v=hmGrI_BVInc

Findings from Plastic Pollution Investigations

Encourage students to summarize findings from their research and the teacher-directed investigations (see previous page), for incorporation into their revised explanations. Invite students to use River Runner and Ocean Plastic Tracker to identify the path of litter when rain washes it from the schoolyard to the nearest stream and then to the ocean.

Environmental Stewardship Project

Engage students in designing and carrying out a project involving fellow students to reduce the amount of plastic waste (especially single use plastics and packaging) or to limit or prevent plastic use.

Revised or Refined Explanation

Allow students to return to their original explanations and revise to reflect what they learned in this lesson, including who / when / how plastics end up in the ocean and what can be done about it. Prompt students to address the standard in the explanation, and to tell about their project's impact and how they could improve its effectiveness.

High School Environmental Science: Trashion Show

Standard

EV5. Obtain, evaluate, and communicate information about the effects of human population growth on global ecosystems.

5a. Construct explanations about the relationship between the quality of life and human impact on the environment in terms of population growth, education, and gross national product.

5b. Analyze and interpret data on global patterns of population growth (fertility and mortality rates) and demographic transitions in developing and developed countries.

5c. Construct an argument from evidence regarding the ecological effects of human innovations (Agricultural, Industrial, Medical, and Technological Revolutions) on global ecosystems.

5d. Design and defend a sustainability plan to reduce your individual contribution to environmental impacts, taking into account how market forces and societal demands (including political, legal, social, and economic) influence personal choices.

Teaching Tips

Preparation Obtain tools and supplies on Materials list including used fabric and clothing; encourage students.

Directions for this lesson are written for teachers. Provide students with the Investigation Lab Report from appendix.

Phenomenon: Present phenomenon in lesson without explanation before or after students view it.

What Do you Notice? Engage students in writing an explanation (or labeled drawing) that tells who, what, why, how.

What Do you Wonder? Engage students in asking their own questions, which will form the basis for their research.

Student Research After each student writes a question, consider placing each question on a sticky note, grouping them in categories, and allowing students to learn more in small groups according to their interests. A curated collection of articles is provided for use in small groups, using the Jigsaw protocol. https://www.jigsaw.org/

Teacher-Directed Activity

Show this video to the class to clarify the problem: The Ugly Truth about Fast Fashion by Hassan Minaj
https://m.youtube.com/watch?fbclid=IwAR2mlJorOZdlg3tWbijlwCr_xIrxIu9Fj8grPVp4gLH17pCH8iAPIExBBLg&v=xGF3ObOBbac

Share and discuss this UN Report on Sustainability in the Textile Industry: https://eco-age.com/resources/un-environment-programme-report-elisa-tonda-sustainability-and-circularity-textile-value-chain/

Provide some of these examples to inspire students for the Challenge:

- Duck Tape's Stuck at Prom; https://www.duckbrand.com/stuck-at-prom
- The Green Hub's Make Do and Mend; https://thegreenhubonline.com/2018/11/26/make-do-mend-how-to-diy-clothes-without-being-a-creative-whizz/
- Makerist's Making Fashion Sustainable; http://blog.makerist.com/making%E2%80%8B-fashion-sustainable-a-makers-guide-to-sustainability/
- Crocheting Plastic Bags into Mats; https://www.goodshomedesign.com/volunteers-crochet-plastic-bags-into-sleeping-mats-for-the-homeless/

Zero Heroes Lesson Activity This is an Eco-Engineering Challenge to re-make discarded clothing into something useful.

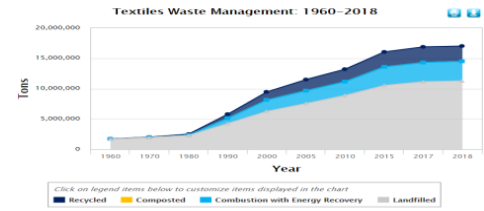
Revised Explanation Prompt students to address the standards highlighted above in their revised explanations.

Teacher Resources

Wandy the Maker on TikTok- https://www.tiktok.com/@wandythemaker?fbclid=IwAR1YJ-lR0qPYBiRR-t4naRc5xKKxisy1c4orQW45INcY-lOXXXFhSt5oQls

Environmental Science - Eco-Engineering Challenge: Trashion Show

The Phenomenon



Credit: EPA web site

What Do You Notice? (tentative explanation)

Engage students in writing about what they noticed when observing data about the phenomenon, including who, what, when, where and how it happens and how they can personally contribute to sustainability. This will serve as their tentative, initial explanation.

Graph: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/textiles-material-specific-data

What Do You Wonder?

Engage students in asking their own questions about the unexplained phenomenon. These questions will form the basis for student research.

The Challenge

- Create a wearable or functional clothing item or accessory by transforming previously-used fabric/clothes. OR
- Repair a torn, broken, or damaged article of clothing so that it is suitable for future use (and possibly restyled) OR
- Organize a Trashion Show or dance, and invite fellow students to create and/or wear re-made or repaired clothes
- Whatever project is selected, provide before and after pictures that show the transformation of used fabrics

Materials Needed

- Used fabrics, table cloths, and clothing, or discards and remnants from fabric stores (not school lost and found)
- Fasteners: Duct or bonding tape, needle and thread, safety pins, hook-and-loop fasteners, safety pins, buttons
- Iron (if fabric bonding tape is used)
- Scissors and pinking shears (which can reduce edge fraying without the need to hem)

Curated Articles for Jigsaw Research www.Jigsaw.org

Ethical Consumer: What is Fast Fashion and Why is It a Problem?
https://www.ethicalconsumer.org/fashion-clothing/what-fast-fashion-why-it-problem
Insider; Nov 8, 2021: Mountain of Unsold Clothing from Fast Fashion Retailers Piling Up in Chilean Desert
https://www.insider.com/discarded-fast-fashion-clothes-chile-desert-2021-11
The World Bank; Sep 23, 2019: How Much Do Our Wardrobes Cost the Environment?
https://www.worldbank.org/en/news/feature/2019/09/23/costo-moda-medio-ambiente
GirlSpring, Jun 1, 2020: Fast Fashion and What It Means for the Planet
https://www.girlspring.com/fast-fashion-and-what-it-means-for-the-planet/
SustainYourStyle: Reducing Our Impact https://www.sustainyourstyle.org/en/reducing-our-impact
US News; Wazir, Zoya; Nov 10, 2021: How Fashion Dumps into the Global South
https://www.usnews.com/news/best-countries/articles/2021-11-11/how-dead-white-mans-clothing-is-clogging-the-global-south
Investopedia; Hayes, Adam; April 29, 2021: Fast Fashion https://www.investopedia.com/terms/f/fast-fashion.asp

Revised Explanation

Allow students to return to their original explanations and revise them to reflect what they learned in this lesson. The explanations should relate to highlighted parts of the standard including ecological effects of human actions and innovations on global ecosystems; and creating a personal sustainability plan to reduce environmental impacts.

Name _____

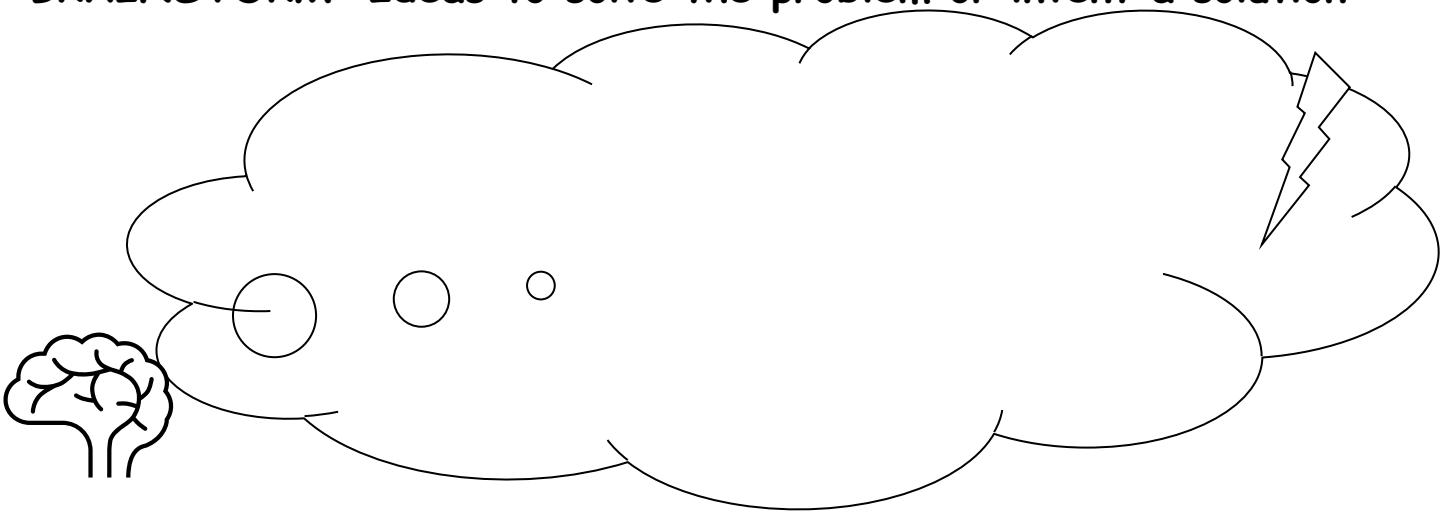
K-2 Eco-Engineering Challenge

WHAT I NOTICED

WHAT I WONDER

WHAT I FOUND OUT

BRAINSTORM: Ideas to solve the problem or invent a solution



MY DESIGN (drawing with labels)

HOW I TESTED MY DESIGN TO SEE IF IT WORKED

HOW I CHANGED MY DESIGN TO MAKE IT BETTER

Name and Date _____

Eco-Engineering Challenge: _____

The Phenomenon*

What I Noticed or Observed

My Initial Explanation of the Phenomenon (What happened, why, and how?)

* A phenomenon is any observable event that has not been explained

What I Wonder (questions about the phenomenon)

Findings from Research / Sources

Eco-Engineering Challenge to be solved and its design constraints (time, budget, materials, etc.)

Design (Labeled Drawing)

How Design was Tested and Improved

Revised Explanation for Phenomenon (continue on back)

Name and Date _____

Environmental Education Alliance of Georgia

Investigation: _____

The Phenomenon*

What I Noticed or Observed

My Initial Explanation of the Phenomenon (What happened, why, and how?)

* A phenomenon is any observable event that has not been explained

What I Wonder (questions)

Findings from Research / Sources

The Investigation (Procedures, Data Analysis, Conclusions)

Revised Explanation of the Phenomenon

Name and Date _____

Community Science Project: _____

The Phenomenon*

What I Noticed or Observed

My Initial Explanation of the Phenomenon (What happened, why, and how?)

* A phenomenon is any observable event that has not been explained

What I Wonder (questions)

Key Research Findings

The Community Science Project (including purpose, procedures, data, analysis, conclusions)

Revised Explanation of the Phenomenon

Name and Date _____

Environmental Stewardship Project: _____

The Phenomenon*

* A phenomenon is any observable event that has not been explained

What I Noticed or Observed	My Initial Explanation of the Phenomenon (What happened, why, and how?)

What I Wonder (questions)

Key Research Findings

Environmental Stewardship Project

Revised Explanation

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The Environmental Education Alliance, Inc. (EEA), a Georgia non-profit organization, is grateful to Environmental Educators of North Carolina (EENC) which, in partnership with Kentucky Association for Environmental Education, provided a sub-grant for this project from Environmental Protection Agency Region 4's Environmental Education Grant #01D14520. The sub-grant covered a portion of the costs of creating the Zero Waste Heroes lesson collection and Teacher Guide as a companion curriculum for the "Don't Waste It" project. Zero Waste Heroes aligns with the Georgia Standards of Excellence in Science and the 3-dimensional learning approach advanced by the "Framework for K-12 Science Education."

For additional information about these lessons or related educator workshops, please contact: info@eealliance.org

www.eealliance.org