



# Zero 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 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



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Each lesson features one or 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 also be explored together by a professional learning cohort.

## Community Science Projects

Community Science projects – formerly called Citizen or Participatory Science - involve students in crowdsourcing 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.



## Culturally-Sustaining Teaching Practices

There are several ways teaching about zero waste can incorporate culturally-sustaining practices, including:

- recognition that each student's culture and experiences result in valuable perspectives to bring to class discussions and brainstorming sessions
- featuring solutions of scientists, inventors, policy makers, and leaders of diverse ages, genders, abilities, and ethnicities, so each 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 locations of hazardous waste dumps or Superfund sites and their health impacts on nearby communities. (<https://www.eealliance.org/ee-landscape-analysis.html>)
- using a curated collection of research articles and a [jigsaw protocol](#), which groups readers of different abilities together to read, discuss and analyze the same article, before returning them to "home groups" where each student is an essential expert who presents information from a different article. Note: this approach is ideal with the same number of students per group as the number of groups and the number of articles. Teachers may assign students to articles based on their common questions.

## 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/](http://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). Then clear up any student misconceptions about the core idea of the standard as well as its application to waste prevention or reduction. A good source of background information about the standard's core idea can be found at the [Wonder of Science](#) web site. Note that Georgia standards are not identical to NGSS standards.



**Teacher Resources** Videos, articles and activities that can be used for the Teacher-directed Activity will be found here.





## Kindergarten – Reuse, Reduce, Rot, Recycle

### 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/](http://www.jigsaw.org/)

**Teacher-Directed Activity** Show this video to students: What Happens to Stuff We Throw Away? (<https://www.youtube.com/watch?v=BjjqkU74IGc>) or substitute a similar book or video

**Zero Heroes Lesson Activity** Students will conduct an investigation by burying various items to see which materials decompose and which do not.

**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



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## K: Reduce, Reuse, Rot, Recycle!

### The Phenomenon

### What do you notice? (tentative explanation)



Credit: The Dodo – [Six Pack Turtle Unstoppable](#) video

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. Use K-2 Lab Report template in 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.

### Curated articles and videos for [Jigsaw Research](#) [www.jigsaw.org](http://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  
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

### Investigate: What can we compost?

DRAW ITEM BEFORE BURYING

/

DRAW ITEM AFTER DIGGING IT UP 30-60 days later

Schoolyard Investigation:

- Let each small group of students select different type of material; bury them; and predict what they will see when dug up in 60 days
- Consider participating in the [Soil You Undies](#) community science project for one part of this investigation (fabric)
- Debrief the activity by asking which items rot if composted; which do not?
- How does what something is made of affect how we use and dispose of it?
- What harm can waste do? (students may focus on injuries to wildlife, as in phenomenon).
- Can we save things by re-using them or re-making them into something else?
- Discuss ideas for how we can reduce the amount of waste in the world.

### Revised Explanation

As a class, discuss and decide on a revised explanation. Encourage students to include at least one reason for appropriately throwing trash in an appropriate waste receptacle (to go to a landfill) or recycling it, rather than littering.



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## 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/Th6GQjSHfKk>
- 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>



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## 1<sup>st</sup> 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 paper from used scraps.

**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.

### Teacher Resources

Boston Children's Museum: Do It Yourself Papermaking for Sustainable Kids (video): <https://www.youtube.com/watch?v=wVlyhgZI-X0>

Simplest approach: [Kid Science- Making Paper](#)

Repurposed Items that are Transformed: [https://www.goodnet.org/articles/10-most-amazing-repurposed-items-youll-ever-see-list?utm\\_source=goodnet-site&utm\\_medium=footer-related&utm\\_campaign=goodnet-related](https://www.goodnet.org/articles/10-most-amazing-repurposed-items-youll-ever-see-list?utm_source=goodnet-site&utm_medium=footer-related&utm_campaign=goodnet-related)



## 2<sup>nd</sup> Grade Eco-Engineering Challenge: Transforming Trash

### The Phenomenon

### What do you Notice? (tentative explanation)



[Lego Build Time Lapse Video](#)

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. Explanations may take the form of labeled drawings. Distribute copies of the K-2 student lab report template from 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.

## Eco-Engineering Challenge: Make Paper from Trash

Your challenge is to make paper from bits of old, used paper.

Paper comes from trees that are cut down and ground up into bits. Then the bits are made into paper. How is this like building with blocks? Can we reduce the number of trees that are cut down to make 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 new paper.

### 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.

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 wiggler 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/>





## 3<sup>rd</sup> 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 wiggler 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](https://jigsaw.org) (jigsaw.org)

- [The Habitat of Red Worms](https://sciencing.com/the-habitat-of-red-worms-13406911.html) (Sciencing.com)
- <https://sciencing.com/the-habitat-of-red-worms-13406911.html>
- [Differences between Earth Worms and Compost Worms](https://sciencing.com/differences-between-earth-worms-and-compost-worms-12498654.html) (Sciencing.com)
- <https://sciencing.com/differences-between-earth-worms-and-compost-worms-12498654.html>
- [How to Identify Red Wigglers at All Stages](https://thrivingyard.com/identifying-red-wiggler-worms/) (ThrivingYard.com)
- <https://thrivingyard.com/identifying-red-wiggler-worms/>
- [Vermicomposting 101](https://foodprint.org/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.



## 4<sup>th</sup> Grade Investigation: Waste Managers in the Wild

### The Phenomenon

### What do you Notice? (tentative explanation)



What are Decomposers? 2:19 – 2:30 Harmony Square  
<https://www.youtube.com/watch?v=JmSz7PGfA>

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 what 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](http://www.jigsaw.org) [www.jigsaw.org](http://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](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=IMW0mCcUjw>

### 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/)

(<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) <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) [https://www.allaboutbirds.org/guide/Turkey\\_Vulture/id](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 phenomenon 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 was happening and how or why did it occur).

**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 research purposes using a jigsaw classroom approach in small groups equal in number of members to the number of articles selected.

**Teacher-Directed Activity** Provide materials for each small group. Take students to the schoolyard to scope out areas with different soils, so they can select areas where they will plant cotton underwear horizontally, 3" deep. Students will measure the weight and dimensions of the underwear before burying it and document the process with photos. Prompt students to make claims about what will happen to the underwear while buried. **Keep the claims and data!**

**Revised Explanation** Allow students to return to and revise their initial explanations of the phenomenon of the pumpkin. Clear up any misconceptions about the role of microorganisms in decomposition.

After digging up the underwear, students will measure and weigh it to compare before and after data.

Provide these prompts for students to write a C-E-R (Claim – Evidence – Reasoning) argument:

- Claim: Restate your original claim predicting what will happen to the underwear while it is buried.
- Evidence: Analyze before and after data to describe the change in the underwear as observed and measured.
- 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 a benefit to humans caused by microorganisms, related to your findings.

Suggested Format: My claim was that \_\_\_\_\_ would happen to the underwear while it is buried. When we dug it up, the underwear had changed in this way: \_\_\_\_\_, 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) we can conclude that the data means this happened: \_\_\_\_\_ which (supports / does not support) my original claim. Knowing what I know now, I (would / would not) change my claim.



## 5<sup>th</sup> Grade Community Science Project: Mighty Microbes

### The Phenomenon



[Decaying Pumpkin](https://www.youtube.com/watch?v=0ReYKu__luA) credit: James Knot  
[https://www.youtube.com/watch?v=0ReYKu\\_\\_luA](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 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 be 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 research. Distribute copies of the student lab report template in the appendix.*

### Curated Articles for [Research Jigsaw](http://www.jigsaw.org) [www.jigsaw.org](http://www.jigsaw.org)

- [Recycling the Dead](https://www.sciencenewsforstudents.org/article/recycling-dead) Science News for Students; Kathiann Kowalski; September 27, 2014  
<https://www.sciencenewsforstudents.org/article/recycling-dead>
- [Healthy Soils are Black Gold](https://www.sciencenewsforstudents.org/article/healthy-soils-life-giving-black-gold-ecosystem-agriculture); 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](https://www.sciencenewsforstudents.org/article/bacteria-are-all-around-us-and-thats-okay); Science News for Students; Lindsey Conkle; October 4, 2018  
<https://www.sciencenewsforstudents.org/article/bacteria-are-all-around-us-and-thats-okay>
- [Biodegradation](https://wiki.kidzsearch.com/wiki/Biodegradation); KidzSearch Safe Wiki  
<https://wiki.kidzsearch.com/wiki/Biodegradation>
- [Decomposition: What Happens When Living Things Die?](https://k8schoollessons.com/decomposition-what-happens-when-living-things-die/); TheK8School  
<https://k8schoollessons.com/decomposition-what-happens-when-living-things-die/>
- [The Soil Food Web](https://jessicagarden.net/wp-content/uploads/2011/02/soil-ffod-web.jpg) infographic; JessicasGarden.net  
<https://jessicagarden.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.)  
[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.](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](https://www.ecoproducts.com/images/pdfs/talking_points/Biodegradation.pdf); EcoProducts  
[https://www.ecoproducts.com/images/pdfs/talking\\_points/Biodegradation.pdf](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 and during planting.  
Plant underwear 3" deep, horizontally.  
Mark spots. Wait 60 days. Dig them up.  
Compare the size and weight.  
Use [this form](#) to report data and [Track](#).

#### Materials

- Cotton underwear (1 per group)
- Shovel or trowels (1 per group)
- Digital scale
- Measuring tape (1 per group)
- Phone or camera to take pics



### 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.*





## 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).





## 6<sup>th</sup> Grade Eco-Engineering Challenge: Innovating to Reduce Waste

### The Phenomenon

### What do you notice? (tentative explanation)



credit: Plastic Pollution Coalition

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 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](http://www.jigsaw.org) [www.jigsaw.org](http://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, containers

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.



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Environmental Education Alliance / [www.eeaalliance.org](http://www.eeaalliance.org)



## Seventh Grade: Particulates, Pollution and Pepper Moths

### Standard

**7L5. Obtain, evaluate, and communicate information from multiple sources to explain the theory of evolution of living organisms through inherited characteristics.**

**5a. Use mathematical representations to evaluate explanations of how natural selection leads to changes in specific traits of populations over successive generations.** (Clarification statement: Referencing data should be obtained from multiple sources including, but not limited to, existing research and simulations. Students should be able to calculate means, represent this data in a table or graph, and reference it when explaining the principles of natural selection.)

**5b. Construct an explanation based on evidence that describes how genetic variation and environmental factors influence the probability of survival and reproduction of a species.**

### Teaching Tips

**Preparation** Provide a variety of materials (not only those in the lesson linked below). See list on next page.

**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. 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 the data shown in the phenomenon OR the data they collected during the simulation. Consider the sources and amount of particulates in London at the time of the industrial revolution and after air pollution regulations were enacted there, compared to amounts and probable causes of particulates in Georgia today (as revealed in the two curated sets of research articles). Engage students in an eco-engineering challenge to design and build a particulate collector and use it to investigate whether particle pollution can be found near school. If so, might particulates have an effect on natural selection in your area? Why / why not? <https://eec.ky.gov/Environmental-Protection/Air/Documents/Particulate%20Matter%20Collector%20Lesson%20Plan.pdf>

**Zero Heroes Lesson Activity** This is an Eco-Engineering Challenge to create a particle pollution collector and use it.

**Revised Explanation** Allow students to return to and revise their initial explanations of the phenomenon. Clear up misconceptions and clarify that particle pollution is a form of waste from power generation, industrial emissions, reactions involving emissions, or dust from construction sites, quarrying, and gravel roads.

### Teacher Resources

This Peppered Moth worksheet from Leeuwen Learning 2020 may be useful:

<https://docs.google.com/document/d/1raW5qOMBKqisdfQqeP8HwME-i8l9cRgo/copy>

or this one from Biology Corner: [https://www.biologycorner.com/worksheets/peppered\\_moth\\_sim\\_key.html](https://www.biologycorner.com/worksheets/peppered_moth_sim_key.html)

After the lesson is finished, the teacher may want to share this article revealing that the iconic Peppered Moth investigation was falsified, and discuss whether this affects student thinking about the impact of environmental factors on natural selection: Science as Process or Dogma in Case of Peppered Moth

<https://www.natureinstitute.org/article/craig-holdrege/science-as-process-or-dogma-the-case-of-the-peppered-moth>



## 7<sup>th</sup> Grade Investigation: Particulate Pollution and Peppered Moths

### The Phenomenon

### What do you Notice? (tentative explanation)

Year	# of Light Moths Captured	# of Dark Moths Captured
2	537	112
3	484	198
4	392	210
5	246	281
6	225	337
7	193	412
8	147	503
9	84	550
10	56	599

Play the Peppered Moth Simulation (<https://askabiologist.asu.edu/peppered-moths-game/how-to-play.html>) and observe the phenomenon, without giving students a chance to read background information or interpretation. Prompt them to graph their data <https://nces.ed.gov/nceskids/createagraph/> from the simulation or from the chart at left. Engage students in writing or drawing what they noticed. This will serve as their tentative, initial explanation for the phenomenon. At the end of the lesson, allow students to revise and refine their explanations to reflect new information and

### Questions: 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 Jigsaw Research [www.jigsaw.org/](http://www.jigsaw.org/)

For everyone to read: Natural Selection and Peppered Moths - <https://askabiologist.asu.edu/peppered-moths-game/natural-selection.html>

For jigsaw research groups to read:

Air pollution - Know Your Enemy <https://www.unep.org/news-and-stories/story/air-pollution-know-your-enemy>

The Air We Breathe Is Polluted <https://climate.nasa.gov/quizzes/air-we-breathe-quiz/>

Science News for Kids - How a Moth Went to the Dark Side <https://www.sciencenewsforstudents.org/article/how-moth-went-dark-side>

Peppered Moths as Evidence of Evolution [https://www.windows2universe.org/cool\\_stuff/tour\\_evolution\\_8.html](https://www.windows2universe.org/cool_stuff/tour_evolution_8.html)

How Air Pollution Affects Animals <https://www.mothersandothersforcleanair.org/documents/AirPollution&Animals2011.pdf>

5 kinds of environmental pollution caused by waste <https://waste4change.com/blog/5-kinds-of-environmental-pollution-caused-by-waste/>

### Eco-Engineering Challenge: Design, Build and Use a Particulate Collector

Design and build a particulate collector. Use it to collect data in the schoolyard and determine whether particulates are in the air near school. Compare your findings with other sources of information about the level and sources of particulate pollution in your area (see sources below) AND make a claim about whether this environmental factor might lead to natural selection over time (generations) near your school and – if so – how.

IQ Air stats

<https://www.iqair.com/us/usa>

Particulate Matter Basics

<https://www.epa.gov/pm-pollution/particulate-matter-pm-basics>

Air Georgia stats

<https://airgeorgia.org/overview.html>

Air Georgia Info re: Particulates

<https://airgeorgia.org/informationaboutpm.html>

### Refined or Revised Explanation: Can Air Pollution affect Natural Selection?

Allow students to return to their original explanations and revise to reflect what they learned in this lesson.



## 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

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](https://www.biologicaldiversity.org/campaigns/native_pollinators/pdfs/Pollinators_in_Peril.pdf) or consult the National Native Bee Inventory and Monitoring Program for community science projects and other possible solutions to native bee decline: <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](https://youtu.be/G6_xXQk6o28). Encourage the class to collectively make a rubric for evaluation of bee 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](http://www.jigsaw.org) [www.jigsaw.org](http://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 natural nesting spaces, resulting from loss of plants and habitat fragmentation. Design a way to restore habitat or a create nesting space that meets the needs of native bee species.

### Constraints

Time Allotted: \_\_\_\_\_

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

Must provide healthy habitat for native, solitary bees

### Materials Needed

- Waterproof container such as used, empty soup or coffee can, jar, or box made of wood, metal, glass, or used plastic
- Hollow stems or similar items such as paper straws, rolled paper, pasta, reeds, wood drilled with holes, etc.
- String or other materials to mount or fasten device in an appropriate place
- Tape for fastening rolled paper into artificial stems
- Drill and bits (optional)

### Revised Explanation

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



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## 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/>



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## 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](https://www.jigsaw.org/) [www.jigsaw.org/](https://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/let-em-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/BeingaGoodNeighbor\\_AGuidetoReducingLitterManagingTrashandEncouragingRecycling.pdf](https://kab.org/wp-content/uploads/2017/10/BeingaGoodNeighbor_AGuidetoReducingLitterManagingTrashandEncouragingRecycling.pdf)  
 Made in GA from Recycled Content <https://www.youtube.com/watch?v=mZPgilCfsx4>  
 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) <https://newsela.com/text-sets/159432/kochanthropologytrash>

### The Community Science Project: Litterati <https://litterati.org/>

Download the Litterati app.  
 Choose a schoolyard or [RiversAlive](https://www.riversalive.org/) 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/) (<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/) (<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/) (<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 an 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 Physical Science: Nuclear Waste

### 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.

**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:

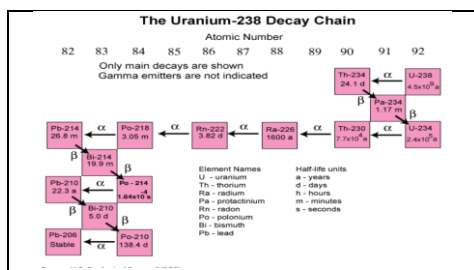
- Claim: Restate your claim regarding whether the merits of nuclear power outweigh nuclear waste issues.
- Evidence: Provide evidence *including data regarding the half-life of nuclear waste* to identify related issues.
- Reasoning: Use the law of conservation of matter as the reasoning that connects 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

### 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 own questions about the unexplained phenomenon. These questions will form the basis for student research.

### Curated Articles for [Research Jigsaw](https://www.jigsaw.org/) [www.jigsaw.org/](https://www.jigsaw.org/)

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](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 Waste

Manage a nuclear plant with this simulation

- Idaho Public Television- Nuclear Power Plant Simulator Game <http://www.nuclearpowersimulator.com/#Start>
- Calculate 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 \_\_\_\_\_.



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## 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/1mx2KK9s3U9fqUwJptlLEAZ2cEHF9XZmA/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:

- 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](#)
- 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](#)
- 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/1uvDCsMEJKMnP5WGodCsNMt5FeuWkEru5AT0Dzcax4k/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>

Engage students in writing what they noticed when observing the phenomenon (or creating a labeled diagram) including who, what, why, where, and how it occurs. This will serve as a tentative explanation while they are making sense of the concepts.

### 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](http://www.jigsaw.org/) [www.jigsaw.org/](http://www.jigsaw.org/)

[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)

<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)

[https://green-alliance.org.uk/marine\\_plastics\\_graphics\\_references.php.php](https://green-alliance.org.uk/marine_plastics_graphics_references.php.php)

[Marine Debris](https://marinedebris.noaa.gov/images/plastics-ocean-infographic)

<https://marinedebris.noaa.gov/images/plastics-ocean-infographic>

[Great Pacific Garbage Patch infographic](https://visual.ly/community/Infographics/environment/great-pacific-garbage-patch)

<https://visual.ly/community/Infographics/environment/great-pacific-garbage-patch>

[Wandering Albatross - characteristics and behavior](https://oceanconservancy.org/wildlife-factsheet/laysan-albatross/)

<https://oceanconservancy.org/wildlife-factsheet/laysan-albatross/>

### Findings from Plastic Pollution Investigations

Encourage students to summarize their findings from the teacher-directed investigations, for future incorporation into their revised explanations.

### 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=IwAR2mJorOZdlG3tWbijlwCr\\_xlrXlu9Fj8grPVp4gLH17pCH8iAPIExBBLg&v=xGF3ObOBbac](https://m.youtube.com/watch?fbclid=IwAR2mJorOZdlG3tWbijlwCr_xlrXlu9Fj8grPVp4gLH17pCH8iAPIExBBLg&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); <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/);

<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%8Bfashion-sustainable-a-makers-guide-to-sustainability/);

<http://blog.makerist.com/making%E2%80%8Bfashion-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 fabric into something useful.

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

### Teacher Resources

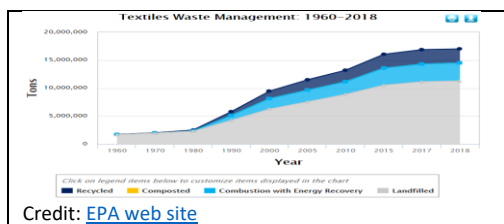
Wandy the Maker on TikTok- <https://www.tiktok.com/@wandythemaker?fbclid=IwAR1YJ-IR0qPYBiRR-t4naRc5xKKxisy1c4orQW45INcY-IOXXXFhSt5oQls>



## Environmental Science - Eco-Engineering Challenge: Trashion Show

### The Phenomenon

### What Do You Notice? (tentative explanation)



Engage students in writing about what they noticed when observing the phenomenon, including who, what, when, where and how it happened. 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 accessory by transforming previously-used fabric. OR
- Repair a torn, broken or damaged article of clothing or fabric so that it is suitable for future use. OR
- Organize a Trashion Show or dance and invite fellow students to create and/or wear remade clothing
- Whatever project is selected, provide before and after pictures that show the transformation of used fabric

### Materials Needed

- Used fabrics, table cloths, clothing- discards and remnants from used clothing stores (not school lost and found)
- Duct tape, bonding tape, needle and thread, safety pins, stick-on hook-and-loop fasteners, safety pins, buttons
- Iron (if fabric bonding tape is used), scissors and pinking shears

### Curated Articles for [Jigsaw Research](https://www.jigsaw.org) [www.jigsaw.org](https://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)

<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)

<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)

<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/)

<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) <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)

<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) <https://www.investopedia.com/terms/f/fast-fashion.asp>

### Revised Explanation

Allow students to return to their original explanations and revise to reflect what they learned in this lesson. The explanation should relate to the highlighted parts of the standard.





## APPENDIX

### Templates and Forms

This appendix includes the following forms:

- Eco-Engineering Challenge Assignment (blank)
- Investigation Assignment (blank)
- Community Science Project Assignment (blank)
- Environmental Stewardship Assignment (blank)
- Engineering Design Process graphic
- Student Eco-Engineering Challenge Lab Report Form (blank)
- Student K-2 Eco-Engineering Challenge Lab Report Form (blank)



## Eco-Engineering Challenge: \_\_\_\_\_

### 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 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](http://www.jigsaw.org) [www.jigsaw.org](http://www.jigsaw.org)



### Eco-Engineering Challenge:



### Constraints

Time Allotted: \_\_\_\_\_

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

### Materials Needed (will vary by project)



### Revised Explanation

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

## Investigation \_\_\_\_\_

### The Phenomenon

### What Do You Notice? (tentative explanation)

### What Do You Wonder? (student questions)

### Articles for Jigsaw Research [www.Jigsaw.org](http://www.Jigsaw.org)

### The Investigation

### Revised Explanation

## Community Science Project: \_\_\_\_\_

### The Phenomenon

### What Do You Notice? (tentative explanation)

### What Do You Wonder? (student questions)

### Articles for Jigsaw Research

### The Community Science Project

### Materials Needed

### Revised Explanation



## Environmental Stewardship Lab Report: \_\_\_\_\_

### The Phenomenon

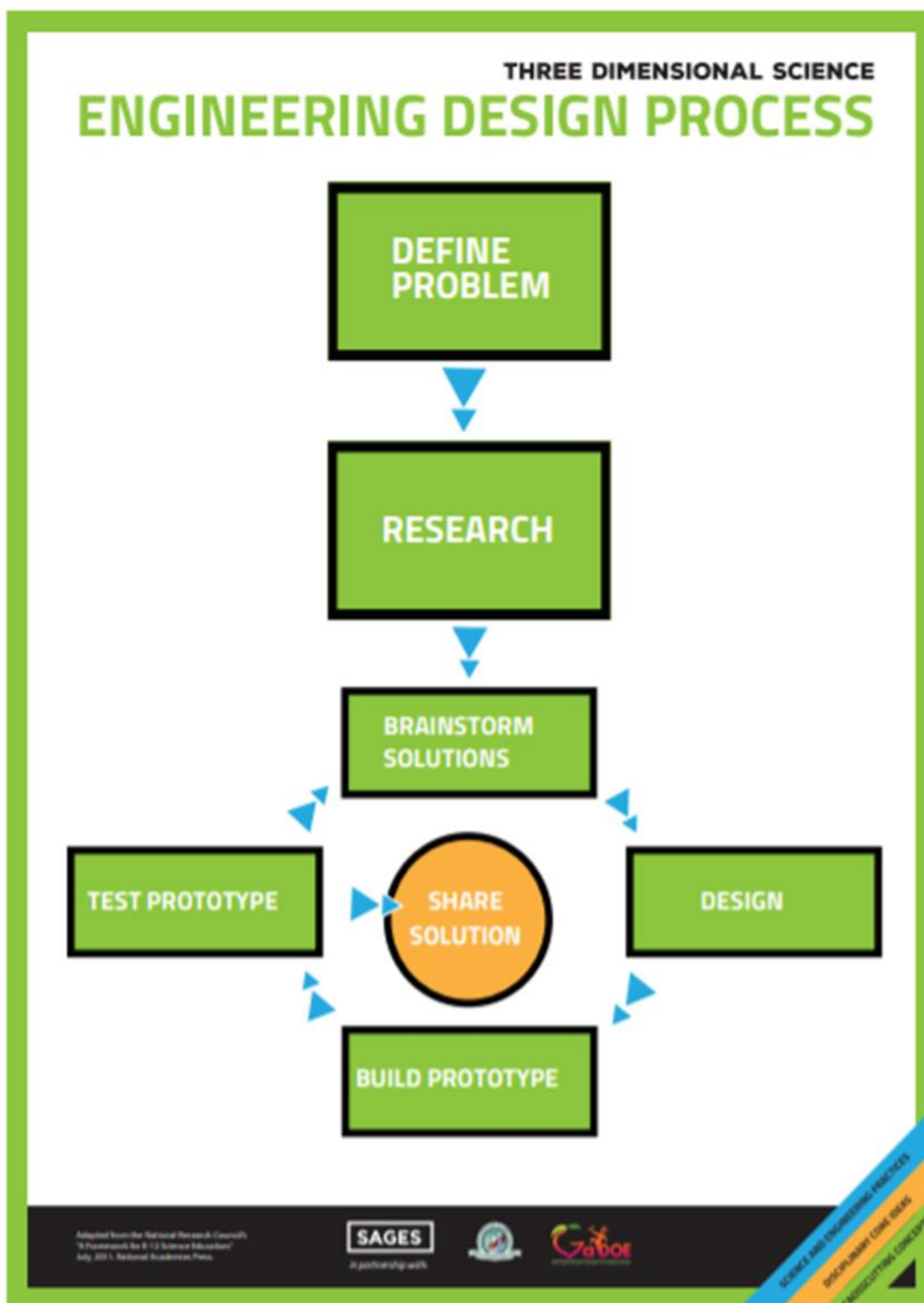
### What Do You Notice? (tentative explanation)

### What Do You Wonder? (student questions)

### Articles for Jigsaw Research

### Environmental Stewardship Project

### Revised Explanation



Credit: Captain Planet Foundation



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## Eco-Engineering Challenge Lab Report: \_\_\_\_\_

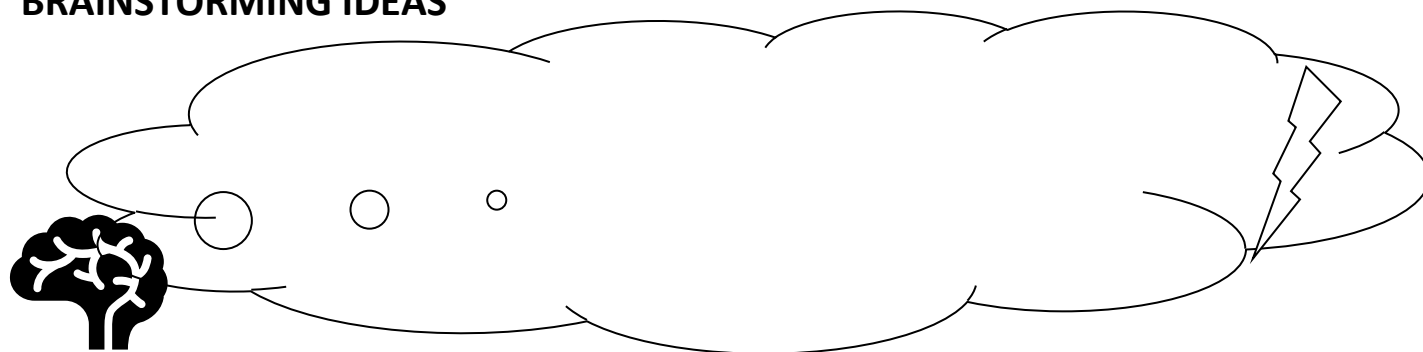
### WHAT DID YOU NOTICE?

### WHAT DID YOU WONDER?

### RESEARCH (Key Points from Curated Articles)

- .
- .
- .
- .
- .

### BRAINSTORMING IDEAS



### DESIGN: labeled drawing



**BUILD:** draw or take a picture of what you built

**TEST:** describe how you tested your prototype; what worked; what didn't work

**REDESIGN:** tell how did you refined or modified the design and how it affected performance

**REVISED EXPLANATION of PHENOMENON (who, where, how, why, so what)**



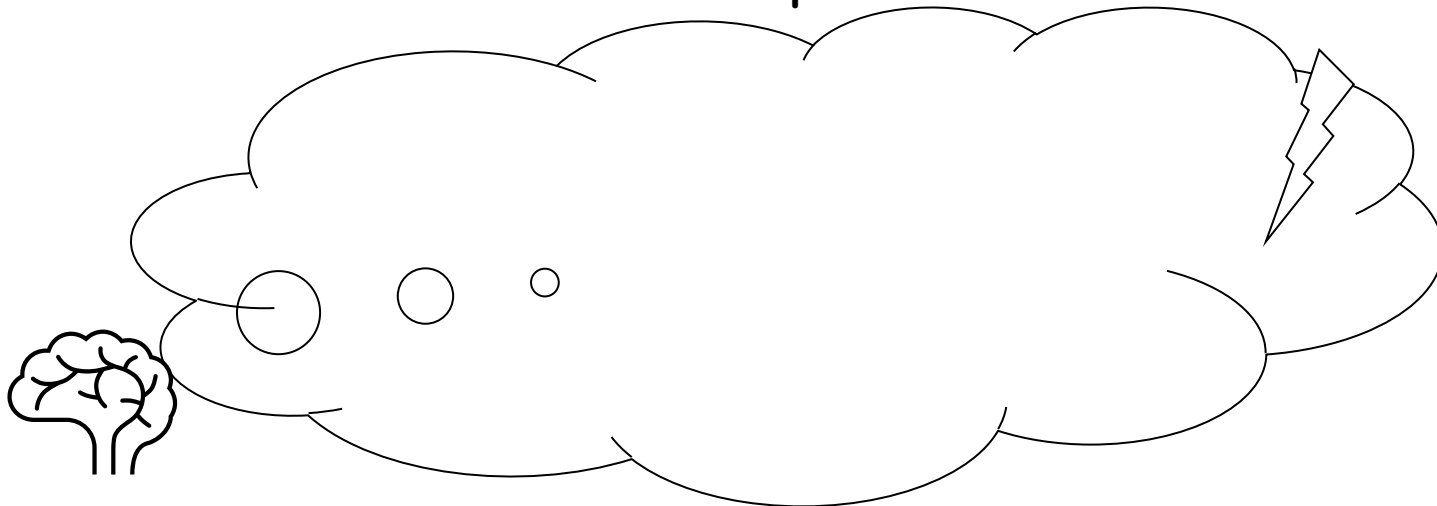
## K-2 Eco-Engineering Challenge: \_\_\_\_\_

**WHAT DID YOU NOTICE?**

**WHAT DID YOU WONDER?**

**WHAT DID YOU FIND OUT?**

**BRAINSTORM IDEAS to solve the problem or invent a solution**



## MY DESIGN: drawing with labels

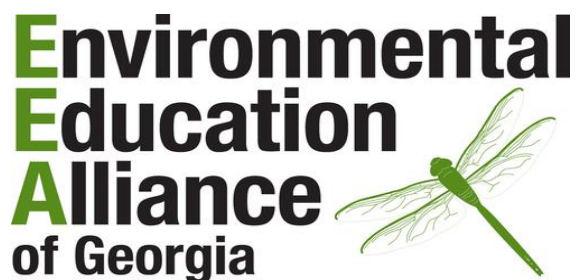
## HOW I TESTED IT TO SEE IF IT WORKED

## HOW I CHANGED MY DESIGN TO MAKE IT BETTER



## Acknowledgments

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For additional information about these lessons or related educator workshops, please contact: [info@eealliance.org](mailto:info@eealliance.org)