WASTE NOT, WANT NOT

Challenge Guide

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Challenge Rationale

In 2015, Americans generated 262.4 million tons of trash. 137.7 million tons ended up in landfills across the U.S.[1] While local communities across the country have responded by increasing recycling initiatives, there is still a major threat as the world population continues to skyrocket — what exactly can we do about our waste? Humans generate tons of waste, not just from the products they use and dispose of but also biological refuse. Everyone seems fascinated by poop, but many fail to realize that after it leaves your toilet, it is going somewhere. Many have a misconception that it is just large agricultural or industrial corporations that produce massive amounts of waste materials, but every day citizens contribute to the global problem. In this challenge, students will learn about various types of waste products and develop a solution that finds a creative way of repurposing it into a useful product.

[1] United States Environmental Protection Agency. (2017). Together we can make a difference: Infographic. Retrieved from https://www.epa.gov/sites/production/files/2019-03/documents/infographic_full-060513_v4.pdf

Establishing The Challenge

Identify a Challenge

"In 2017, worldwide material consumption reached 92.1 billion tons…a 254% increase from 27 billion in 1970."[2] According to the US Census Bureau, the world population in 2019 was 7.6 billion people. By 2040, that number will be approaching 9 billion. As the world continues to add more living beings to the planet, all of whom are producing waste material in their everyday lives, one has to ask, what can be done about the world's waste? In the United States, over 50% of solid waste material ends up in landfills, approximately 26% is recycled, and the remainder is either composted or incinerated. Many states have developed comprehensive recycling programs to limit the amount of solid waste material humans are sending to landfills. These include: materials and food packaging, disposable silverware, and hygiene products. But what about the other type of solid waste materials that humans generate — poop? Are there creative strategies that could be put into place or unique products that could be developed that would allow for the development of "brown energy"? In this challenge, you will be learning about various waste products and tasked with identifying creative strategies and solutions for reducing their negative impact on the environment.

[2] United Nations, Department of Economic and Social Affairs. (2023). 12: Ensure sustainable consumption and production patterns. Retrieved from https://sustainabledevelopment.un.org/sdg12

Establishing The Challenge

Challenge Question

How can we improve the ways in which waste products are disposed of in the US?

THIS SOLUTION MUST ADDRESS THE FOLLOWING NEEDS:

- Creative uses for waste products
- Innovative solutions for reusing waste
- Trade-offs of not disposing of waste in unique ways

SUCCESS WILL BE DETERMINED BY:

- Development of a solution that uses waste products in an innovative way to create a useable product
- Producing and sharing a presentation that communicates knowledge gained

Standards Addressed

Next Generation Science Standards

nextgenscience.org

- HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Common Core Standards

corestandards.org/mathematics-standards

- CCSS.MATH.CONTENT.5.OA Write and interpret numerical expressions.
- CCSS.MATH.CONTENT.5.NBT Perform operations with multi-digit whole numbers and with decimals to hundredths.
- CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.
- CCSS.MATH.PRACTICE.MP4 Model with mathematics.

corestandards.org/english-language-arts-standards/

- CCSS.ELA-LITERACY.SL.9-10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
- CCSS.ELA-LITERACY.W.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- CCSS.ELA-LITERACY.W.11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Guiding The Challenge

Each Purple Plow Challenge can be implemented in a variety of methods, time frames, and programs. Follow the steps below to help determine how this challenge will best fit the current situation and educational environment.

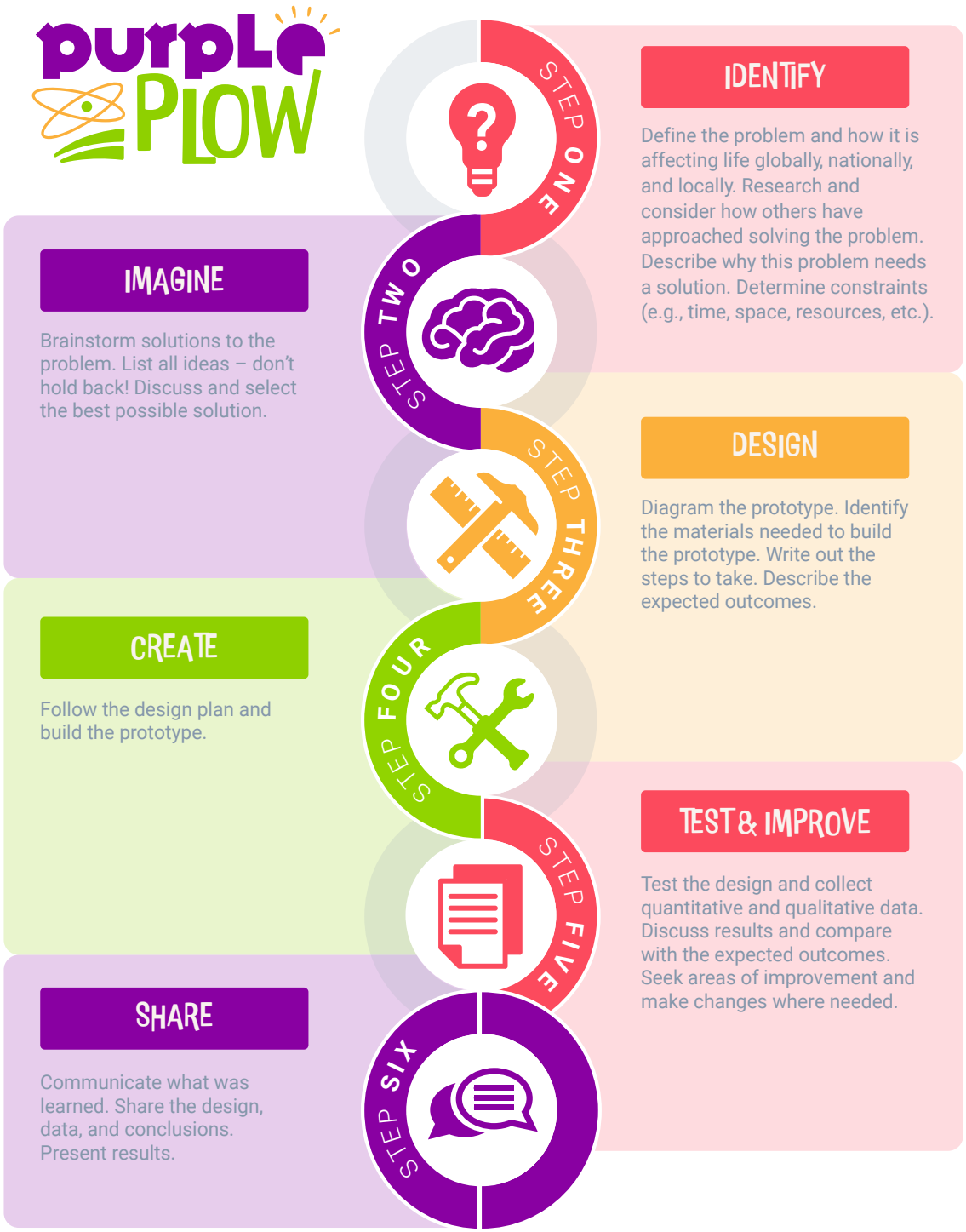
1. **REVIEW** the Purple Plow "Design Process" (next page) and the "Lesson Packet" documents. Note that the lessons are encouraged but not required.
2. **EXAMINE** the suggested timeline to determine ways to integrate the challenge and lessons to fit your needs.
3. With the time frame in mind, **USE THE GUIDANCE PROVIDED** in this section to help students progress through the challenge. This guidance includes suggested student prompts, guiding questions for students, signs of step completion, and journaling opportunities. The student prompts, guiding questions, and journal prompts are found in the "Student Guide." Facilitators or students may determine the method by which they record their research and discoveries found for these prompts and journal reflection questions.

SUGGESTED TIMELINE

This sample pacing guide is created for a 20-day calendar with a 45-minute class. It is important to remember that timing may vary on student's pace, as well as how much time you dedicate to each of the steps listed below. Your students may return to certain steps and repeat the process, no journey is the same!

DESIGN PROCESS STEP	TIMELINE
Identify	4 days
Imagine	2 days
Design	2 days
Create	5 days
Test & Improve	5 days
Share	2 days

Challenge Design Process



Materials List

Suggested Materials List

The items listed below are suggested materials needed to conduct the challenge. Facilitators and students are encouraged to be creative and inventive in acquiring the materials needed to complete the challenge (e.g., purchased, recycled, donated, etc.).

MATERIALS REQUIRED	SUGGESTED MATERIAL OPTIONS
• Computer with internet access	• Printer • Variety of paper (e.g., poster board, presentation board, construction paper, etc.) • Creative Materials (e.g., scissors, glue, etc.) • Coloring supplies • Calculator • Presentation software (e.g., Google slides, PPT) • Variety of materials for model development (This will depend on type of project created; try to use recycled materials.)

STEP ONE

1 | IDENTIFY

Purpose of Step

Define the problem and how it is affecting life globally, nationally, and locally. Research and consider how others have approached solving the problem including how people have addressed this problem historically. Describe why this problem needs a solution. Determine constraints (e.g., time, space, resources, etc.).

Student Prompts and Guiding Questions:

- What is waste?
- What impact does human waste have on ecosystems? Human health? Society?
- What are the ways in which waste products are disposed of?
- What might happen if waste is not properly disposed of?
- What is needed to break down waste?
- How can waste products be used to generate energy?
- What are the effects of high amounts of methane being released into the atmosphere?
- Where does human waste go?
- Where does animal waste end up?

Signs of Step Completion

Students will present a description of the challenge to the facilitator. They should include how this problem affects communities globally, nationally, and locally. The description should also include ways in which others have addressed finding a solution and constraints to be considered (e.g., time, space, resources, etc.).

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE "WASTE NOT, WANT NOT" STUDENT GUIDE.

STEP TWO

2 | IMAGINE

Purpose of Step

Brainstorm solutions to the challenge. List all of your ideas – don't hold back! Discuss and select the best possible solutions.

Student Prompts and Guiding Questions:

- What types of products are currently made from waste materials?
- How do different industries attempt to recycle waste products?
- What are the potential global benefits to reusing waste?
- Where else can waste products go if not sent to a landfill?
- How can sustainable projects be developed for managing the world's waste?
- In what ways can people be educated about creative waste management?
- What are the local and global consequences of not reusing waste products?

Signs of Step Completion

Students will present a list of possible solutions to the identified challenge to the facilitator.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE "WASTE NOT, WANT NOT" STUDENT GUIDE.

STEP THREE

3 | DESIGN

Purpose of Step

Develop a possible solution and identify the materials needed to provide evidence for why the solution is creative, unique, and sustainable. Write out the steps to take and describe the expected outcomes.

Student Prompts and Guiding Questions:

- What type of waste product will be the focus of your creative solution?
- How will you demonstrate how the waste product is being reused?
- What materials are needed?
- What environmental factors should be considered?
- How do material costs and other creative constraints factor into sustainability of possible outcome?
- Justify your potential solution.

Signs of Step Completion

The students will present a detailed description of the solution as well as a written plan of how it could be carried out. Look for the following in the plan: a materials list with budget (if building a physical model or conducting lab research), detailed directions, and expected outcomes.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE "WASTE NOT, WANT NOT" STUDENT GUIDE.

STEP FOUR
4 | CREATE

Purpose of Step

Follow the design plan and construct the solution.

Student Prompts and Guiding Questions:

- Use all research, knowledge gained, and the design plan to create the solution.
- Repeat any of the previous steps should issues arise during the building process.
- Consider the parameters of the challenge and what needs to be accomplished for a successful challenge.

Signs of Step Completion

The students will construct the solution and share with the facilitator.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE "WASTE NOT, WANT NOT" STUDENT GUIDE.

STEP FIVE

5 | TEST & IMPROVE

Purpose of Step

Test the design and collect qualitative and quantitative data. Discuss results and compare with the expected outcome. Seek areas of improvement and make changes where needed.

Student Prompts and Guiding Questions:

- What will need to be observed (i.e., qualitative data)?
- What information can be put into a chart or graph (i.e., quantitative data)?
- Create data tables, graphs, or photographs showcasing data, etc.
- How will you demonstrate the benefits of your possible solution?
- How will you evaluate the tradeoffs of NOT incorporating your solution?

Signs of Step Completion

The students will keep records of all test trials and share data with the facilitator. Entries should include both qualitative and quantitative data. The students will also share recordings of any improvements made to the solution and the effect they had on the outcome.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE "WASTE NOT, WANT NOT" STUDENT GUIDE.

STEP SIX
6 | SHARE

Purpose of Step

Communicate what was learned throughout the challenge. Share the design process, data, and conclusions on how the solution answers the challenge question.

Student Prompts and Guiding Questions:

- Develop a presentation including knowledge gained, design plans, and materials used to develop a potential solution that is creative and sustainable.
- How is your solution an appropriate, innovative solution that realistically responds to the precise design competition problem?
- How does your solution address budgetary constraints, timeline issues, and other potential challenges?
- How successful was your solution in addressing the elements of the challenge?
- Describe and/or demonstrate what you learned from this challenge.

Signs of Step Completion

The students will present what was learned through the design process, including sharing how the solution addresses the problem, key aspects of design, data from test trials, and end results.

Extension Possibilities

- Visit and tour a wastewater treatment plant.
- Invite a knowledgeable guest speaker to discuss waste management with the class.
- Explore a company that converts waste to energy or makes unique products from collected waste such as Bureo, Allbirds, or Ecovative.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE "WASTE NOT, WANT NOT" STUDENT GUIDE.

Additional Resources

The resources listed below are links to additional information to help you and your students complete the Waste Not, Want Not Challenge. In addition, be sure to check out the supplemental lessons on the Purple Plow website.

Curriculum

World Population Review
http://worldpopulationreview.com/

Waste Management
https://www.wm.com

National Geographic
http://nationalgeographic.com/

Trellis Group
https://trellis.net

World Resources Institute (WRI)
http://wri.org/

New Scientist
http://newscientist.com/

RCN Montana – Bioprospecting Ethics and Benefit Sharing
https://rcn.montana.edu/Publications/Detail.aspx?id=177

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