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# ROOM TO GROW

Challenge Guide

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## Challenge Rationale

Students locally can contribute to the impact problems of population growth, access to resources, limited space for growing food, and year-round plant-based food production. After thoughtful research to evaluate how these challenges exist globally and locally, students will design, build, and utilize a growing structure that can be used in their unique location or situation to help maximize the availability and access of food given the extensive growth in population and limitations of space. The final product will be a functioning greenhouse structure with crop yield being analyzed.

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# Establishing The Challenge

## Identify a Challenge

The world population is growing at a rate of 1.13% per year. The current average population change is estimated at around 80 million per year (www.worldometers.info). The expanding population is creating less and less growing space and there is a need for year-round production. There are limitations of available resources due to the factors of this growth. Around the world, there are remote locations with limited resources to allow for climatically controlled growing. Individuals in large urban areas struggle with finding the space to grow food.

<sup>1</sup> American Farm Bureau Foundation for Agriculture Food and Farm Facts <https://www.agfoundation.org/resources/food-and-farm-facts-2019>

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# Establishing The Challenge

## CHALLENGE QUESTION

How can you contribute locally to the impact problems, such as population growth, limited space for growing food, access to resources, and year-round plant-based food production? What type of growing structure would help reduce the effects of a global or national problem such as the ones listed above?

Design, build, and utilize a growing structure that can be used in your unique location or situation to help maximize the availability and access of food.

### THIS SOLUTION MUST ADDRESS THE FOLLOWING NEEDS:

- Produce a plant-based food source
- Maintain an environment that is suitable for plant life for a maximum of 90 days
- Must maximize production per square footage

### SUCCESS WILL BE DETERMINED BY:

- Harvest an edible food product within 90 days or show progress of plant growth within the time frame allotted for your specific situation
- Create and maintain an environment that is suitable for plant life

# Standards Addressed

## Next Generation Science Standards

<https://www.nextgenscience.org>

- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

## Common Core Standards

<https://corestandards.org/mathematics-standards/>

- Geometry 6.G Solve real-world and mathematical problems involving area, surface area, and volume.
- Geometry 7.G Draw, construct, and describe geometrical figures and describe the relationships between them.

# Guiding The Challenge

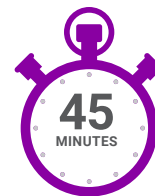
Each Purple Plow Challenge can be implemented in a variety of methods, time frames, and programs. Follow the steps below to help determine how this challenge will best fit the current situation and educational environment.

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 90-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	3 days
Imagine	6 days
Design	6 days
Create	6 days
Test & Improve	64 days
Share	5 days



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# Guiding The Challenge

## SUGGESTED TIMELINE (CONT.)

To fulfill the requirements of the challenge, you will need time beyond the allotted program time above. Possible options for completing include:

- Sending the constructed growing structure and related materials home with students wishing to compete (participating in regular progress monitoring of project with facilitator)
- Developing continuation options in an after-school or extra-curricular club with facilitator
- Including parents in the process of continuing the investigation (with option of providing space at school to keep project)

# Challenge Design Process



## IMAGINE

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

## CREATE

Follow the design plan and build the prototype.

## SHARE

Communicate what was learned. Share the design, data, and conclusions. Present results.

## IDENTIFY

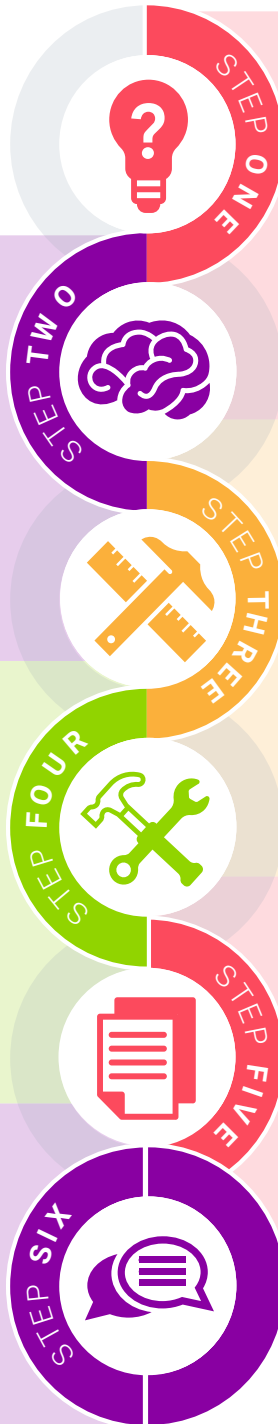
Define the problem and how it is affecting life globally, nationally, and locally. Research and consider how others have approached solving the problem. Describe why this problem needs a solution. Determine constraints (e.g., time, space, resources, etc.).

## DESIGN

Diagram the prototype. Identify the materials needed to build the prototype. Write out the steps to take. Describe the expected outcomes.

## TEST & IMPROVE

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



# 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
<p>Plant Needs:</p> <ul style="list-style-type: none"> <li>• Selected plant species</li> <li>• Plant holding materials</li> <li>• Soil or soilless medium</li> <li>• Water source</li> </ul>	<p>Plant Needs:</p> <ul style="list-style-type: none"> <li>• Seeds, plants or plugs</li> <li>• Pots, beds, flats, or various containers</li> </ul>
<p>Construction Needs:</p> <ul style="list-style-type: none"> <li>• Framing materials</li> <li>• Necessary connections to piece together the framing materials</li> <li>• Hand tools</li> <li>• Glazing materials to cover the growing structure</li> </ul>	<p>Construction Needs:</p> <ul style="list-style-type: none"> <li>• PVC pipe, lumber, aluminum</li> <li>• Nails, glue, angled PVC connector pieces, string, tape</li> <li>• Saw, hammer, drill, wire cutters, or scissors</li> <li>• Glass, plastic, or plastic wrap</li> </ul>
<p>Optional Needs:</p> <ul style="list-style-type: none"> <li>• Lighting</li> <li>• Heat source or model of heat source with explanation</li> </ul>	<p>Optional Needs:</p> <ul style="list-style-type: none"> <li>• Solar supplemental lighting, such as: greenhouse lights, string lights, LED strips, grow lights, wire or light bulbs/lamps</li> <li>• Water heater, space heater, hair dryer, or boiler</li> <li>• Small fans, greenhouse openings               <ul style="list-style-type: none"> <li>- ridge vents/side vents, vented openings, or louvers</li> </ul> </li> </ul>

# 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:

- How does population growth affect how plants are grown?
- What are the limitations for how food can be grown?
- What effect does population growth have on the available resources to grow foods?
- How can we be more efficient about where, what, and how plants are grown?
- What types of plants are being grown locally?
- What are the plant-based food needs in the local community?
- What is the accessibility to fresh plant-based foods in the local community?
- What types of plant-based foods could be produced year-round?
- Considering the local climate, what is the length of the growing season and how does that impact what types of plants can be grown?

### 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 "ROOM TO GROW" 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 do plants need to grow?
- What space is available to grow plants year-round?
- What are some unique places to grow plants year-round?
- What structures can be used to grow plants?
- What types of climate fixtures (e.g., heating, cooling, lighting, ventilation, irrigation, etc.) are needed to grow plants?
- What materials can be used to build these growing structures?
- What types of materials are unique to the local community?

### 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 "ROOM TO GROW" 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:

- Design a structure that meets the demands set forth in the challenge.
- Determine what specific materials would be used in the construction.
- Justify why particular design choices have been made.
- Justify why particular materials have been chosen.
- What crops will successfully grow in the growing structure?
- Create a supply list and budget.
  - a. What specific materials will be used to build the growing structure?
  - b. How will materials be obtained?
  - c. What is the cost of these materials?
- In what ways will the production of the growing structure be measured?
  - a. What will need to be observed (qualitative data)?
  - b. What information can be put into a chart or graph (quantitative data)?

### 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 "ROOM TO GROW" 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 model.
- 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 "ROOM TO GROW" 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:

- Analyze the production of the growing structure created.
- Create data tables, graphs, photographs showcasing production, etc.
- Calculate growth efficiency.
- Based on the data, what predictions can be made about the sustainability of the growing structure?

### 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 "ROOM TO GROW" 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 create the model, testing completed during challenge, and data analysis.

### 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.

**AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE "ROOM TO GROW" STUDENT GUIDE.**

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