PuRPLe PLoW

Uncovering STEM Solutions

Challenge Design Process

STEP ONE

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.).

STEP TWO

IMAGINE

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

STEP THREE

DESIGN

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

STEP FOUR

CREATE

Follow the design plan and build the prototype.

STEP FIVE

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.

STEP SIX

SHARE

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

PURPLE PLOW
Uncovering STEM Solutions

Purple Plow Challenge Design Rubric

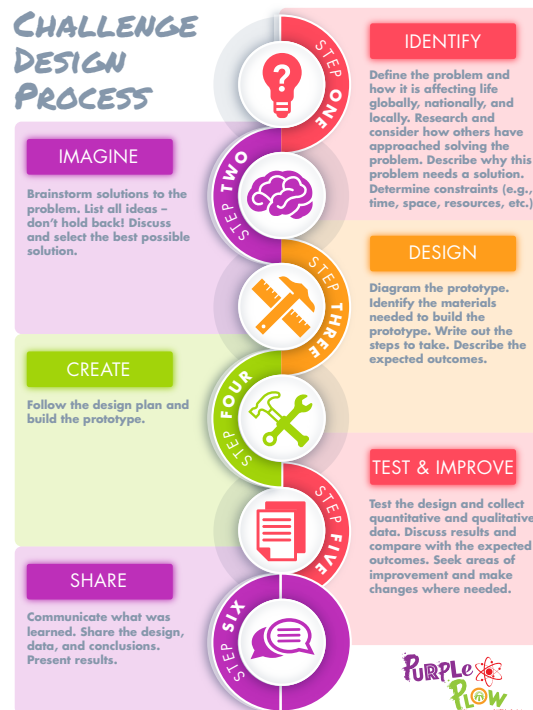|	Unsatisfactory	Beginning	Developing	Exemplary
Identify & Imagine	Solution does not address the challenge.	Solution addresses the challenge and demonstrates significance.	Solution addresses the challenge, demonstrates global significance, national implications, and local impact.	Solution addresses the challenge, demonstrates global significance, national implications, and local impact. It is meaningful to the participants and their community.
Design	Design shows no evidence of research. Sketches aren't included. The written plan isn't organized and is hard to follow.	Design shows little evidence of research and careful deliberation. Sketches are included with little or no labeling. The written plan has little organization and is hard to follow.	Design shows some evidence of research and careful deliberation. Sketches are included with some labeling. The written plan is organized and could be followed to completion.	Design shows clear evidence of research and careful deliberation. Detailed sketches are included and have every part labeled. The written plan is well-organized and clearly describes each step to completion.
Create	Prototype was built freely and a material list isn't included. Materials were handled and stored improperly and safety rules weren't followed.	Prototype was built freely and a material list is included. Materials were handled and stored properly and safety rules were followed.	Prototype was built from a team plan and a detailed material list is included. Materials were handled and stored properly and safety rules were followed.	Prototype was built from a team plan with detailed procedures. A detailed material list is included. Materials were handled and stored properly and safety rules were followed.
Test & Improve	Prototype wasn't tested and inadequate data was collected.	Prototype was tested for a specified amount of time. Conclusions were drawn from prototype testing.	Prototype was tested for a specified amount of time with some data collection. Conclusions were drawn from data collected during prototype testing. Improvements were made to address identified system failures.	Prototype was tested for a specified amount of time with extensive data collection. Conclusions were drawn from data collected during prototype testing. Graphs/charts were used to project outcomes and identify system failures. Improvements were made to address identified system failures and inadequacies.
Share	Findings were not shared with the class or were hard to understand. Student logbooks were not used.	Clear and concise perspectives on what was learned about the topic and the process were shared with the class. Student logbooks were used minimally.	Clear and concise perspectives on what was learned about the topic and the process were shared with the class in a unique way. Student logbooks were used regularly to record the design process.	Clear and concise perspectives on what was learned about the topic and the process were shared with the class in a unique way. Student logbooks were used regularly to record the design process. Findings were presented in a unique way to a broader audience.

Purple Plow
Challenge Supply List

Identify the types of materials and tools needed to complete the design prototype.
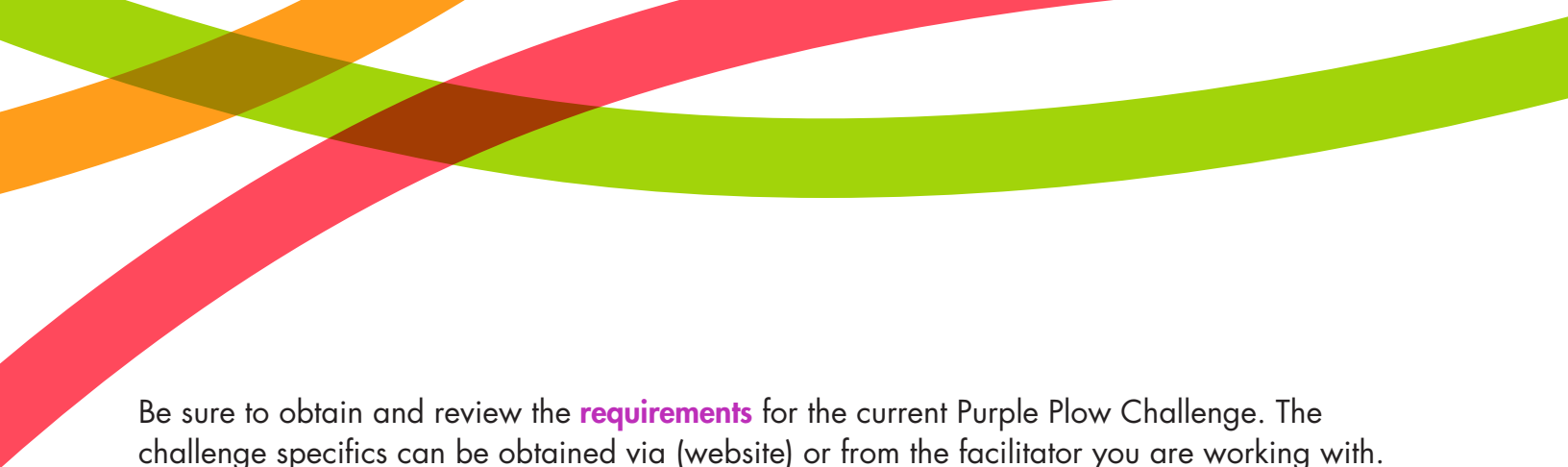
Purple Plow Challenge Volunteer Guide

Thank you for assisting with the Purple Plow Challenge!

- Introduce yourself to the students you are working with.
- Provide students with some introductory information about yourself.
  - Share what you feel comfortable with about your **personal** life.
    - *Suggested topics:*
      - Where did you to go school?
      - What level of education have you received?
      - Do you have a family (children)?
- Provide students with some introductory information about your **professional** life. Again, share only what you feel comfortable sharing.
    - *Suggested topics:*
      - What do you do with the company?
      - What do you like about your job?
      - Have you done other jobs with the company?

Be familiar with the **Design Process** and the ways in which you can help students throughout this process.

Challenge Design Process

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SHARE — STEP SIX
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Purple Plow

Be sure to obtain and review the **requirements** for the current Purple Plow Challenge. The challenge specifics can be obtained via (website) or from the facilitator you are working with.

When is a good time to provide classroom assistance?

- *Early on in the challenge -*
  - o Students can explain their project and justify materials. You may be able to assist with this process.
- *After student projects are constructed and underway -*
  - o You can assist by having students explain their projects details, how the project is going, and what their initial results and findings are.
- *After the projects and experiments are concluded -*
  - o Students can share their findings with you. You can assist them in thinking about extension opportunities for their project or improvements that can be made.

When engaging with students, be…

- friendly.
- available.
- willing to communicate.
- willing to share ideas.
- collaborative with students.

If you are unsure of how to specifically engage with students, below are some **suggested questions** to ask a group working on a challenge project. These may be asked at different times throughout the process or where they best apply (based on when you are assisting with the project).

1. What is the goal of your challenge project?
2. How are you going to meet the challenge requirements?
3. What can I help you with to assist you in completing your project?
4. Why did you choose to design your project in the way that you did?
5. Why did you choose the materials that you did to construct your project?
6. What information did you get from your initial results?
7. What would you change if you were doing this challenge again?
8. What was the hardest part of completing the challenge?
9. What did you like most about your project?
10. What are some of the marketing strategies you developed as a result of your project?

Purple Plow Challenge
Supply List & Budget

Material	Purpose	Quantity	Unit Cost	Total
			Total Cost	

Submitted by: _____   Approved by: _____

Tips for Success

Get ready to embark on an exciting Purple Plow Challenge! The following suggestions are included to assist in the successful facilitation and implementation of the Purple Plow Challenge. These suggestions are offered to help in tailoring the experience for a variety of settings: in the classroom, as an after-school program, as a summer school program, etc. Realizing not all facilitators will have a background in education, these tips will help any volunteer facilitating this challenge.

Facilitator's Role and Responsibilities

The facilitator serves as a guide in the learning process. The facilitator's roles and responsibilities will vary based on the set-up of the challenge (e.g., part of a middle school science class, after-school program, etc.), but generally include:

- Establishing a creative, safe working environment
- Guiding students through the engineering design process
- Encouraging discourse and the exploration of unique ideas
- Monitoring student progress
- Securing needed materials
- Assisting students in keeping and organizing a logbook
- Connecting students to resources
- Communicating with school officials

Setting Up Teams

When setting up teams for the challenge, consider group dynamics and how the challenge will be implemented. For example, if this is an after-school club, there may only be one team and one finished product. In a regular classroom, establishing several independent teams to address the challenge will increase engagement. Consider the following guidelines when establishing effective teams:

- Teams of four are shown to be the most effective. The group can work as a team without being overwhelmed by too many members, and can split into two pairs for various tasks. If the class is not divisible by four, teams of three or five are fine, but avoid teams of greater than five members.
- Teams should be as heterogeneous as possible. Be sure there is a mix of both boys and girls in each group, and that there is a range of academic abilities.

- Establish work space for each team and assist them in keeping their areas organized and safe.
- Allow time for teams to get to know each other. Consider engaging in teambuilding activities or icebreakers in the first week of the challenge. This will allow each member to get acquainted with their team and will

The Hook

Consider launching the Purple Plow Challenge with an engaging hook or introduction. Your hook should engage student interest and initiate curiosity. A successful hook inspires students to seek content knowledge and promotes inquiry. The hook could be just about anything. Here are a few ideas to consider:

- A lively discussion/debate
- A guest speaker
- A field trip
- An engaging video
- A mock correspondence that sets the scenario

Team Member Roles & Responsibilities

Roles with clear responsibilities for teams may be established within teams or classes. The following roles will support the Purple Plow Design Process. Although all students should participate in each stage of the design process, and will likely engage in multiple roles throughout the process/challenge, these roles may provide structure for the participants. Here is a list of possible roles to consider:

- **Project Manager** – manages team throughout the process, keeps team on track to meet goals, manages team morale, assumes responsibility for productivity
- **Materials Manager** – manages team supplies and materials, keeps materials organized and inventoried, seeks new materials as needed
- **Treasurer** – manages the team budget, researches material costs, manages any fundraising
- **Reporter** – develops a structure to record team progress, manages public and private online communities for the project, works closely with the media specialist to share progress
- **Media Specialist** – manages the production process for all of the media that is used throughout the project, edits and organizes all media used on the project
- **Researcher** – conducts further research beyond the initial background, seeks answers to team questions

Engage a Volunteer

Access a local DuPont Pioneer representative, or representative from the field of agricultural science, to come in and serve as a coach during the challenge. Specific opportunities to engage volunteers are outlined in the "Purple Plow Challenge Volunteer Guide."

Establish a Routine

The following table provides a suggested outline for day-to-day operation. It is intended to give consistent structure during each Maker Session while honoring the engineering design process. Specific timing will depend on each participant's unique situation and setting.

	Key Components	Key Questions
Team/Class Meeting (Whole Group)	At the start of each session, meet with your team or teams. Discuss any new insights and/or what has already been done and the challenges that have been addressed. Be sure to guide students to think about what they will do today.	• What is going well? • What has been a challenge? • What part of the process are you currently in? • What do you plan to work on today?
Engagement (Team Work)	This is the work time that the students will use to work through the engineering design process. Expect groups to work in and out of each step.	• Who might be the best person on your team to complete…? • Where are you in the process? • What support do you need for…? • What routes to solving the problem have you already tried?
Reflection (Independent)	Provide students with a few minutes to quietly reflect on their day's work. During this time, students should use their logbooks to record observations and thoughts.	• What did you learn today? • How is this related to…? • How might you solve…? • How many possibilities can you think of and why?
Debrief (Whole Group)	Conclude each session with a whole group meeting to discuss what was completed in the session. Discuss successes, challenges, and failures.	• What did you complete today? • What do you need to complete…? • What's next? • What things did you try that didn't seem to work? • Describe how your team solved a problem today.

Create a Recognition Board

Collaboration and teamwork need to be supported and celebrated. Dedicate a visible area in the room for a "Recognition Board" (alternative names: "Props Board" or "Shout-Out Board"). This could be a bulletin board, a large blank poster on the wall, or even the back of a door. The idea is to provide a space for students to leave notes of encouragement or thanks as they work through the steps in the design process.

TASK CARD

DIRECTIONS: Use this task card to help stay on track for the duration of the challenge.
- (1) Look at the task you need to complete
- (2) Find the worksheet inside of the packet
- (3) Read the directions on the worksheet out loud (**Sign initials**
- (4) Discuss/research/analyze in your groups to complete the task
- (5) Have someone record (**Sign initials**

		Due Date:	Initials of Who Read	Initials of Who Recorded	Teacher Stamp When Complete
IDENTIFY	Everyone seems to have "problems" these days. Whether it be teen drama, or a broken phone app, we need to "identify" the issue so we know what we are dealing with.	_____	_____	_____	_____
IMAGINE	Be creative! Be practical! Be amongst today's best scientists by becoming someone who thinks about an issue today and finds a new approach to solving it.	_____	_____	_____	_____
DESIGN	Ever try to design your own pokemon? Or, ever tried to doodle on a desk (and got in trouble)? Now is your chance to put those creative juices to a good purpose!	_____	_____	_____	_____
CREATE	If you have ever made paper airplanes or built a transformer, you got this! And even if you haven't, just go for it! Always be willing to try something new.	_____	_____	_____	_____
TEST & IMPROVE	Okay, so maybe it didn't go as well as originally planned. That's okay! All science experiments need to be changed and altered once in a while in order to get the best results.	_____	_____	_____	_____
SHARE	Sharing is caring. And science is no different! Remember how we always need to record detailed data? Little did we know that would help us help others with their own research!	_____	_____	_____	_____

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