Project Transport Design Challenge

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Overview

In this activity, students are posed with a problem: A classmate has broken their arm and has a cast from their wrist to their shoulder. They are unable to carry anything with that arm for the next six weeks. This week is the science fair at school and everyone is working on their project both at home and at school. It is due at the end of the week and this student now has to find a way to safely get their project back and forth to school, despite their broken arm and the predicted rain forecast. Students will need to design something that will help their classmate carry and protect their project as they travel back and forth to school for the week.

Standards *- Note: This activity can be adapted to meet numerous technology and engineering state standards depending on the depth the teacher wants to go into. The teacher can choose to simply have the students draw and explain their design or they could invest more time and ask the students to build, test and redesign a prototype. Therefore, the standards will vary depending on what the teacher chooses to incorporate. A list of grade level standards that link to the activity is given below.*

MA Physical Science Standards

PreK-PS1-2(MA). Investigate natural and human-made objects to describe, compare, sort, and classify objects based on observable physical characteristics, uses, and whether something is manufactured or occurs in nature.

PreK-PS1-3(MA). Differentiate between the properties of an object and those of the material of which it is made.

PreK-PS1-4(MA). Recognize through investigation that physical objects and materials can change under different circumstances.

Clarification Statement:

- Changes include building up or breaking apart, mixing, dissolving, and changing state.

2-PS1-1. Describe and classify different kinds of materials by observable properties of color, flexibility, hardness, texture, and absorbency.

2-PS1-2. Test different materials and analyze the data obtained to determine which materials have the properties that are best suited for an intended purpose.*

Clarification Statements:

- Examples of properties could include, color, flexibility, hardness, texture, and absorbency.
- Data should focus on qualitative and relative observations.

MA Technology and Engineering Standards

1.K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change that can be solved by developing or improving an object or tool.*

1.K-2-ETS1-2. Generate multiple solutions to a design problem and make a drawing (plan) to represent one or more of the solutions.*

2.K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same design problem to compare the strengths and weaknesses of how each object performs.*

Clarification Statements:

- Data can include observations and be either qualitative or quantitative.
- Examples can include how different objects insulate cold water or how different types of grocery bags perform.

3.3-5-ETS1-1. Define a simple design problem that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost that a potential solution must meet.*

3.3-5-ETS1-2. Generate several possible solutions to a given design problem. Compare each solution based on how well each is likely to meet the criteria and constraints of the design problem.*

Clarification Statement:

- Examples of design problems can include adapting a switch on a toy for children who have a motor coordination disability, designing a way to clear or collect debris or trash from a storm drain, or creating safe moveable playground equipment for a new recess game.

3.3-5-ETS1-4(MA). Gather information using various informational resources on possible solutions to a design problem. Present different representations of a design solution.*

Clarification Statements:

- Examples of informational resources can include books, videos, and websites.
- Examples of representations can include graphic organizers, sketches, models, and prototypes.

4.3-5-ETS1-3. Plan and carry out tests of one or more design features of a given model or prototype in which variables are controlled and failure points are considered to identify which features need to be improved. Apply the results of tests to redesign a model or prototype.*

Clarification Statement:

- Examples of design features can include materials, size, shape, and weight.

4.3-5-ETS1-5(MA). Evaluate relevant design features that must be considered in building a model or prototype of a solution to a given design problem.*

5.3-5-ETS3-1(MA). Use informational text to provide examples of improvements to existing technologies (innovations) and the development of new technologies (inventions). Recognize that technology is any modification of the natural or designed world done to fulfill human needs or wants.

5.3-5-ETS3-2(MA). Use sketches or drawings to show how each part of a product or device relates to other parts in the product or device.*

6.MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.*

6.MS-ETS1-5(MA). Create visual representations of solutions to a design problem. Accurately interpret and apply scale and proportion to visual representations.*

Clarification Statements:

- Examples of visual representations can include sketches, scaled drawings, and orthographic projections.
- Examples of scale can include ¼" = 1'0" and 1 cm = 1 m.

6.MS-ETS1-6(MA). Communicate a design solution to an intended user, including design features and limitations of the solution.

Clarification Statement:

- Examples of intended users can include students, parents, teachers, manufacturing personnel, engineers, and customers.

6.MS-ETS2-1(MA). Analyze and compare properties of metals, plastics, wood, and ceramics, including flexibility, ductility, hardness, thermal conductivity, electrical conductivity, and melting point.

6.MS-ETS2-2(MA). Given a design task, select appropriate materials based on specific properties needed in the construction of a solution.*

Clarification Statement:

- Examples of materials can include metals, plastics, wood, and ceramics.

7.MS-ETS1-2. Evaluate competing solutions to a given design problem using a decision matrix to determine how well each meets the criteria and constraints of the problem. Use a model of each solution to evaluate how variations in one or more design features, including size, shape, weight, or cost, may affect the function or effectiveness of the solution.*

7.MS-ETS1-4. Generate and analyze data from iterative testing and modification of a proposed object, tool, or process to optimize the object, tool, or process for its intended purpose.*

7.MS-ETS1-7(MA). Construct a prototype of a solution to a given design problem.*

8.MS-ETS2-4(MA). Use informational text to illustrate that materials maintain their composition under various kinds of physical processing; however, some material properties may change if a process changes the particulate structure of a material.

Clarification Statements:

- Examples of physical processing can include cutting, forming, extruding, and sanding.
- Examples of changes in material properties can include a non-magnetic iron material becoming magnetic after hammering and a plastic material becoming rigid (less elastic) after heat treatment.

8.MS-ETS2-5(MA). Present information that illustrates how a product can be created using basic processes in manufacturing systems, including forming, separating, conditioning, assembling, finishing, quality control, and safety. Compare the advantages and disadvantages of human vs. computer control of these processes.

HS-ETS1-6(MA). Document and present solutions that include specifications, performance results, successes and remaining issues, and limitations.*

Science and Engineering Practices *(https://ngss.nsta.org/PracticesFull.aspx)*

- Asking Questions and Defining Problems
- Developing and using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Engaging in Arguments from Evidence
- Obtaining, Evaluating and Communicating Evidence

Lesson Timeline *(Two 45 min class periods)*

Duration	Activity	Instructions
5-10 mins	Introduce the Problem	Read "The problem" to the class. Discuss and allow time for questions. Put students into groups.
30-35 mins	Materials Exploration	Give the students several objects *(objects should be made of a variety of materials – consider things like paperclips, cardboard box, scissors, crayons, wooden pencil, plastic mechanical pencil, string, pipe cleaners, fabric, sheet protector, tin foil, etc…)* to explore in their groups. Have them write each object on the chart. They should discuss and record what **material** each object is made of *(wood, plastic, metal, etc…)* and brainstorm what **properties** that material has *(bendable, strong, hard, ability to be shaped, soft, holds its shape, smooth, rough, transparent, flexibility, water resistance, etc…)* including why that material was good for that object. Once they have explored each material, they should discuss which types of materials would be good to use for the Project Transport that they will be designing.
45 mins	Introduction & Design	Have students complete the Student Design Handout. Allow time for sharing and feedback from other students.
Possible Extension to the Activity *(Two to three 45 min class periods)*		
45 mins	Design challenge	If time allows, students can build and test their prototype using a variety of recycled materials and craft supplies
45 - 90 mins	Group share & redesign	If time allows, students can share their design solutions *(allow time for comments, questions or feedback).* Students should redesign and retest their solutions, sharing their final product.

Learning Targets

- **Day 1** - I can explore a variety of materials to determine what properties will be useful in my design.
- **Day 2** – I can generate a solution to a design problem and create a drawing to represent my design solution.
- **Day 2** - I can present my solution to other students and accept feedback
- **Day 2** - I can provide feedback to other students on their design solution.

Optional Extension

- **Day 3,4 & 5** - I can utilize the engineering design process to design, test and redesign a prototype that will solve a problem.

Materials

- Student Design Handout
- Lined Paper or graph
- Colored pencils

Examples for the Materials Exploration *(teacher choice)*

- Paperclips
- Cardboard
- Scissors
- Crayons
- Pencils (wooden & mechanical)
- String
- Pipe cleaners
- Fabric or felt
- Sheet protectors or transparency paper
- Other

Extension materials could include:

- Cardboard
- Craft materials (popsicle sticks, plastic cups, tin foil, construction paper, clay, etc…)
- Plastic bags
- Scissors
- Rulers
- Tape (masking tape, duct tape, etc…)
- Other

Vocabulary

Criteria – the requirements that must be met by the project
Constraint – a limitation or condition that must be satisfied by a design. *(common constraints include time, cost, and materials)*
Prototype – the first model of the solution

Name: _____ Date: _____

Project Transport Design Challenge

THE PROBLEM: A classmate has broken their arm and has a cast from their wrist to their shoulder. They are unable to carry anything with that arm for the next six weeks. This week is the science fair at school and everyone is working on their project both at home and at school. It is due at the end of the week and this student now has to find a way to safely get their project back and forth to school, despite their broken arm and the predicted rain forecast. You will need to design something that will help your classmate carry and protect their project as they travel back and forth to school for the week. *(Note: It is expected to rain 3 days this week and your classmate has no choice but to walk to school, one mile, with their project.)*

THE CHALLENGE: You will need to design something that will help your classmate carry and protect their project as they travel back and forth to school for the week.

Criteria:

- The project that they will be carrying is a 2 ft x 3 ft piece of poster board that has items sticking up on it, giving it a 3-D effect.

Constraints:

- The only materials you have to work with are the materials provided by the teacher
- You have a limited amount of time *(as instructed by your teacher)*

Step 1 – Explore, analyze and compare a variety of materials to determine what properties make them useful ***(Complete the table on the back of this paper)***
Step 2 - Decide what MATERIAL(s) your design should be made of – *(label on your drawing)*
Step 3 - DRAW and LABEL what your design will look like *(on lined paper or graph paper)*
Step 4 - Explain WHY each material is a good choice *(what properties does that material have that make it a good choice?; strong/durable, lightweight, waterproof, etc....)*

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Extra: If you have extra time, come up with something else that you could design to make your life easier! Be Creative!!

Materials Exploration

The purpose of this activity is to have you think about properties of materials and why engineers choose different materials for different objects.

Instructions: Look at each object you are given and determine what material(s) it is made of. Write these on the chart. Then describe what properties the material has *(is it soft, strong, flexible, water resistant, bendable, absorbent, etc…)*

Object	Material	Properties	Why is this a good property for this object?

Based on what you learned, **circle** the materials that you think would be good to use for your Project Transport Design. **Can you think of other materials that might be useful?**