Major Project: Engineering Design Challenge

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STEM Endeavor Certification Project

Phase I - Research and Planning

Big Concept

Energy converts from one form to another.

Standards

Common Core State Standards for Mathematics

CCSS.MATH.PRACTICE.MP1
Make sense of problems and persevere in solving them.

CCSS.MATH.PRACTICE.MP5
Use appropriate tools strategically.

CCSS.MATH.CONTENT.4.MD.C.6
Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.

NGSS

4-PS3-4 Energy
Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

3-5 ETS1 Engineering Design
3-5 ETS1-1: Define a simple problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2: Generate and compare multiple solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Standards for Technology Literacy

Design

STL 9 Grades 3-5: The engineering design process involves defining the problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
STL 9 Grades 6-8: Design involves a set of steps, which can be performed in different sequences and repeated as needed.
STL 9 Grades 6-8: Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

ELA/Literacy

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

Type of Problem Solving

Designing an air-powered rocket to hit a distant target is a moderately structured problem. Even though there are constraints with resources and time in this challenge problem, there is more than one way to design, create, and test a rocket that will hit the specified target. Designing, creating, and refining the rocket prototype requires mental modeling and evaluation skills. Declarative knowledge of aerodynamics is also needed to solve this problem effectively. All of these characteristics demonstrate that the air-powered rocket design challenge problem is a moderately structured problem.

Types of Knowledge

Declarative knowledge is needed throughout the design challenge process. To solve the problem, students use knowledge of these facts, concepts, and principles:

- Definition of potential and kinetic energy
- Know the potential energy of air stored inside the balloon changes to kinetic energy making the rocket move
- Definition and purpose of a rocket
- Know major parts of a rocket
- Know steps for engineering design process
- Know distance-angle relationship of an object in flight
- Basic understanding of aerodynamics
- Definition of a fraction

Procedural knowledge is needed to create, refine, test, and evaluate the air-powered rocket and it's performance. When solving the problem, students will use knowledge of the following skills:

- Design a straw rocket with criteria and constraints
- Draw a diagram of the rocket and launcher
- Build a balloon-powered launcher
- Build a air-powered rocket
- Blow up a balloon-powered launcher
- Test air-powered rocket
- Evaluate the launch angle of the rocket

- Evaluate the weight of the rocket
- Evaluate the ability to fly straight
- Evaluate the balloon's pressure
- Redesign and make changes to the rocket
- Measure angles
- Write a fraction to show the number of times rocket hits the target

Objectives

Students will be able to:

- apply scientific ideas to design, test, and improve a device that converts energy from one form to another
- explain that energy from the air in the balloon is potential energy and the energy making the rocket move is kinetic energy
- describe the change from potential energy to kinetic energy
- explain how they used experimentation and testing to repeatedly revise their design of the rocket
- design and build a small scale air-powered rocket and launcher
- measure launch angle
- write the number of times their rocket hits the target as a fraction
- explain the rocket features that helped their rocket hit the target
- identify the parts of their group's rocket
- explain how changing the launch angle affects the flight of the rocket

Ancillary Concepts

- Position and Motion of Objects - path of the rocket is a curved path
- Properties of Objects and Materials - plastic straws, latex balloons, copy paper, transparent tape, modeling clay
- Motion and Forces - rocket moving through air

Possible Activities

- Students can use such objects as pennies, batteries, bulbs, wires, motors, hand cranks, golf ball and ping pong balls to demonstrate how energy can be transferred from one object to another.
- Designing and building an air-powered rocket carrying a satellite or space shuttle that can hit a distant target.

Best Activity for Fourth Grade Class

Designing and building an air-powered rocket that can hit a distant target.

References

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