Lori Fine
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Dr. Josh Brown
The “E” in STEM

Engineering Challenge Phase 1

Selected Project

Students will design and build a Rube Goldberg, or Chain Reaction, Machine to perform a task of their choosing. Specs: Each machine will incorporate at least 5 of the 7 simple machines, as well as demonstrate 2 of the 3 laws of motion. Constraints: They may only use repurposed materials, no items may be purchased for the construction of their machine.

Big Concept

1) The Big Science Concepts for this challenge will be Simple Machines and Newton’s Laws of Motion. The Big Engineering Concept will be an emphasis on iterative testing and refining our final product, while maintaining a healthy mindset focused on problem-resolution. The Big Social-Emotional Concepts will be on teamwork, active listening, and decision making.

Learning Standards

NGSS Science Standards:

a) MS-PS-2-1 Collision Design Solution - Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.
b) MS-PS-2-2 Forces, Mass and the Motion of an Object - Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.
c) 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. (Grades 6 - 8)
d) MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (Grades 6 - 8)
e) 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. (Grades 6 - 8)

Types of Problem Solving and Knowledge:

f) **Declarative**:
   i) The simple machines are the simplest devices that can be used to create a mechanical advantage to increase force. They consist of the inclined plane, wedge, screw, lever, pulley, wheel & axle. They have few, or no moving parts and are used to change motion and amount of force needed in order to do work.
   ii) Newton's 3 Laws of Motion dictate how objects move. The first law states that an object will continue to do what it has already been doing. The second law states that an object that has an unbalanced force acting on it will accelerate the direction of the unbalanced force. The third law states that for every action there is an equal and opposite reaction.

g) **Procedural**:
   i) According to the Jonassen article, building a Rube Goldberg machine would be classified as a design problem. This type of problem will require students to engage in extensive problem structuring as they define their goal and determine a solution that will satisfy ill-defined requirements. It will also require commitment and self-regulation by students as they experience many failures and iterations as part of the design process. Because the criteria for acceptable solutions are not necessarily obvious, students must construct their own system for assessing the effectiveness of their final product.

Objectives/Ancillary Subjects

h) Simple machines allow us to use less force to do the same amount of work because they allow the force to be spread over a distance.
i) Understanding W = F x d and the relationship between the variables.
j) Transfer of energy
k) Potential vs. Kinetic Energy. How all the objects in the Rube Goldberg are at rest with gravity being potential energy, and the initial motion as the original kinetic energy. Then observing the transfer of energy through each component of the Rube Goldberg.

Possible Activities

l) We could take a week or two of class to do investigations on each one of the simple machines to see how we need less force to do the same amount of work by mathematically calculating it using the formula.

m) We could break down each of the 3 laws of motion and explore how to build different components in our Rube Goldberg machines that demonstrate an example of each.

Phase I – Research and Planning – Due Date: Midterm

- ☑ ~~1. Identify the "Big" concept to be covered by the engineering design challenge.~~
- ☑ ~~2. Research appropriate learning standards associated with the topic.~~
- ☑ ~~3. Identify and discuss the different types of problem solving and declarative/procedural knowledge needed.~~
- ☑ ~~4. Explore objectives and ancillary concepts/content covered by the project.~~
- ☑ ~~5. Identify possible activities.~~
- ☑ ~~6. Select the best activity for your classroom.~~

Resources

LEGO People Mover
Simple Machines & Rube Goldberg Challenge
Design and Build a Rube Goldberg

Explanation
Reach Engineering Design Process Notebook