Food delivery challenge

Focus question
How can gravity be used to feed several chickens at the same time?

Standards
- **6.PS.3**: There are two categories of energy: kinetic and potential.
- **7.PS.3:** Energy can be transformed or transferred but is never lost.
- **8.PS.1**: Objects can experience a force due to an external field such as magnetic, electrostatic, or gravitational fields.

Introduction
This lesson introduces the Food Delivery Challenge, in which students must design a gravity feeder to carry food (chicken feed) to twelve hungry chickens for over 24 hours. To accomplish the task students must design and build a model of an efficient gravity feeder using the available materials available to them.

Scenario presented to the class: *One of the feeders in your uncle's barn has broken down, and a new one will not arrive until next month. You must create a gravity feeder to satisfy 12 chickens for 24 hours consistently.*

Student prior knowledge
In this lesson students will be connecting concepts of providing nutrients in equal disbursements with the rise/fall of gravitational energy. It will be important for students to understand that gravity is a force that pulls on an object without touching the object.

Suggested timeline
4–5 days

Materials
- Empty paper towel tubes
- Empty toilet paper tubes
- Tape
- String
- Cups
- Recycled plastic bottles
- Birdseed or chicken feed
- Card stock
- Popsicle sticks
- Pocket scale

Teacher preparation
Before class, set up a table with the supplies students will need to build their gravity feeders (see materials section).

Procedure

This lesson is in 4 phases:

DAY 1: RESEARCH

Students research gravity feeders online and/or watch the two video resources to identify different shapes for gravity feeders. After researching gravity feeders, groups brainstorm the basic shape of the feeder and pros and cons of each style. Students will then select a gravity feeder to build using this information.

DAY 2: DESIGN

Teams plan and sketch a prototype to meet the conditions described above. Explain to students that they are to work in groups to construct a gravity feeder using any or all of the materials provided on the table. Tell them that they will be able to test their design before they decide on their final design. Then invite students to sketch a design. Remind them that the goal of the Food Delivery Challenge is to create a way to feed 12 chickens in 24 hours consistently. Encourage them to think about critical questions such as: *Which parts of the design will be important for this goal ? How will gravity be used in the design? What do you already know about potential and kinetic energy that will be helpful in the design? What might be the most economical way to build this design?*

DAY 3: BUILD

Teams build and test their 3-D prototype for scale using the materials provided.

DAY 4: TEST TRIALS AND REDESIGN

As a class, compare the gravity feeder designs of the student groups. Create a chart to record students' predictions about which feeder would satisfy 12 chickens in 24 hrs consistently and why. Guide the class in a compare-and-contrast discussion of the successes of each feeder. Ask: *What patterns do you notice? What key features led to successful designs?* Teams decide how to improve upon their original design and revise their gravity feeders. Teams should be encouraged to consider the size of chickens and how their size will affect the amount of space they need to use the gravity feeder.

Active questions

DAY 1: RESEARCH

1. What are the observations you made about the feeders in the video?
2. Which feeder or feeders appear to work best and why?
3. What features of the feeder did you like and why?
4. Which feeder appeared the most efficient and why?
5. What were the differences between the 3 feeders?
6. Is there another design that you thought of that might work better than the ones included on the videos?

DAY 2: DESIGN

1. Looking at the materials the teacher has provided, which feeder seems the most logical to create?
2. What substitutions for materials can be made and how?
3. How does creating a scale model rely on an understanding of relative size and distance?
4. What is the relationship between structure and function in your design?
5. Structures can be designed to serve a particular function by taking into account properties of different materials and how materials can be shaped and used. What considerations is your team thinking about related to structure and function in your design?

DAY 3: BUILD

1. How does your design relate to one of the feeders in the video?
2. What features of your team's prototype allow for efficiency?
3. What observations can your team make about other teams' designs to gather ideas and reflect on in an effort to improve your design?
4. What feedback from other teams will you use to improve your design?

DAY 4: TEST TRIALS AND REDESIGN

1. What rubric score did your prototype receive after test trial one?
2. How will you improve your prototype?
3. What rubric score did your prototype receive after test trial two?
4. Did your total rubric score improve?
5. Are there any other ways you can improve your prototype?
6. What was your final rubric score?

SUGGESTED WRAP-UP ACTIVITY

Teams use the rubric to see what score other groups' prototypes receive after test trial 1. Have the groups compete to see whose feeder works the fastest, has the least amount of spillage, or has the capacity to feed the most animals. The teacher can make the activity more challenging by limiting the materials and creating a time limit for the design and build portions of the lesson.

More challenges

- Challenge the students to consider if their design will work with various kinds of feed and if not, why?
- Ask students to make a list of everything that scientists and engineers might do during the design process (i.e., invent, re-invent, improve, etc). In groups, have students identify the steps of the design process they experienced by concepting the design process using the terms the group identified and defined.

Home connection

Create a pet feeder or waterer that will consistently feed or water your pet for 24 hours or more.

Support information

- Engineers design solutions to problems. Agricultural engineers apply science and engineering principles as they design solutions to problems in agricultural production. They've invented machinery, improved production systems, improved plants and animals, and found ways to take care of the environment.

Safety tips

During phase 3, use caution when cutting cardboard and/or plastic. Always ask for help when needed.

Teaching suggestions

- After the test trial, have teams take a gallery walk to view other teams' designs for possible ideas to assist them in the analysis and redesign portions of the engineering design process. If teams are successful on the first try, encourage them to make their prototypes even more efficient. If it is a scenario that is not possible, distribute team members to other teams to act as a support person for them in making their prototypes more efficient. If after a third test the final prototype is still unsuccessful, have the students write how they would start over. These challenges are meant to have students build on what they originally designed. If the design was unsuccessful, encourage a reflection or justification on what they would do if they were allowed to start over from scratch. What would they do differently?

- This lesson is presented using the Constructivist Theory of Learning where students construct new knowledge from their experiences. This approach promotes the idea that children learn by doing. When students are asked to create a prototype for scale they might not have the background knowledge of how chickens feed. They will need to use their creativity and imagination to address the problem. Your students, while in the role of "engineers", should be allowed to test and retest their ideas in order to gain a better understanding of the design.

Career connections

Have you ever wondered what type of poultry careers help to make a healthy, safe environment for commercial birds? Let's take a look!

- **Nutritionists** are animal scientists who create diets for different types of poultry by examining their genetics, health conditions or other factors to best determine their nutritional needs.
- **Equipment manufacturers** design and manufacture machinery needed for poultry such as waterers, climatic controls, feeders, egg and meat processing and packaging.
- **Engineers** design, test and implement a wide array of equipment such as conveyor belts and processing equipment to improve efficiency.

Resources for phase 1

- How to build a gravity feeder for deer (time: 1:24–3:45): **youtu.be/vQ3St1qXO0A**
- How to build a gravity feeder for chickens (time: 0:50–1:45): **youtu.be/iwPQAivZlEc**