Physics Egg Drop Project

Purpose: With deliveries being delivered by drones by companies like Amazon, packaging construction becomes even more important. In addition to being able to protect the contents, package must also be lightweight and durable. Drones must be able to safely fly and maneuver while carrying the package. This will limit the amount of mass of the package material, and thus can affect the protection it offers to the contents. Students will use this real-world design problem and apply it to a physics unit about Newton’s second law. This project is a twist on the traditional egg drop. Students will use engineering principles to create an egg container that will withstand a drop of 10 meters.

Overview: Students will work in pairs to create an egg launch container. Once it is made, the students will use drones to drop the container from varying heights. Students will calculate force, mass and acceleration of the containers.

Oklahoma Science Standards: HS-PS2-1. Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net forces in a macroscopic object, its mass, and its acceleration.
Oklahoma Science Standards: HS-PS2-3. Students who demonstrate understanding can apply science to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
Oklahoma Math Standards: HSN-Q.A.1: Reason quantitatively and use units to solve problems. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Objectives: Students will design and build an egg drop device, no larger than a 6-inch cube, and with a mass of no more than 150g. Students will drop the device from heights from 10 meters. Additionally, the students will graph force/time and use preliminary data to predict future plotting points on the graph. Students will be assessed on engineering design, appropriate use of lab measuring devices, mathematical principles, and graphing skills.

Materials: The instructor will provide handouts, scales and rulers, a 15 cm cube box, and 2 eggs per group. Students will brainstorm for and provide materials to use for their egg drop launch container. Materials will be recycled or common household objects. Students are not allowed to buy items to create their container, nor are they allowed to use egg cartons or plastic eggs. Suggested materials include newspaper, cotton balls, paper towel spindles, straws, etc. Students are encouraged to brainstorm and be creative. Students are responsible for verifying their containers are the appropriate size and mass. They may or may not choose to use the 6-inch
cube box as the outer shell of their egg drop container, but the container may be no larger in any dimension than the 6-inch box. Drop containers cannot contain gels or liquids and can’t have a parachute apparatus.

Assessment: Students will be assessed for prior knowledge before the start of the unit, and after completion. Students will be required to write a one-page reflection on what they did, what they’d do differently.

Adaptations/Modifications: On level students will not be required to complete the written reflection, but to complete it as a group. Groups will be created with differing levels of abilities, and with scaffolding in mind. ELL and SPED students can use graphic organizers, drawings, and/or translation apps.

Procedure: Day 1:
Students will take an assessment over Newton’s second law, and how force, mass and acceleration are related.

Using a custom-built force impact platform, students will drop a box, six inches per side, with a mass of 150g from a multiple heights. Data will be collected and graphed to correlate the force of impact versus height of the drop. Students will then be asked to extrapolate the data and predict the force of impact from a height of 10 meters.
Day 2:
Students will be shown the following videos as an introduction.

- **Amazons first drone concept video:**
  https://www.youtube.com/watch?v=98BIu9dpwHU
- **Bloomberg video about start-up drone company:**
  https://www.youtube.com/watch?v=TedKIllo0c04
- **Amazon’s latest drone delivery video:**
  https://www.youtube.com/watch?v=3HJtmx5flFc

Students will have one hour to construct an egg drop container. Students will be given a box. The container must be no larger than a 6-inch square, and no more than 150g. Groups can make more than one prototype but can only launch one.

**Days 3-4:**
Students will weigh their package to ensure it is below the maximum weight, otherwise the drone will not be able to lift the package.
Students will attach box to a drone using a release mechanism on the bottom of the drone. The drone will be programmed to automatically fly to a specific coordinate and hover. The launch platform will have a remote release that will be triggered to release the egg drops from a height of 10 meters onto the landing pad. Students will open the box to determine if the egg survived the fall. Students will record data from impact with landing pad.

Students will write a report describing the results of their egg drop. Calculations will be completed to predict the velocity of the box upon impact based upon the release height. Acceleration will be calculated by dividing the force recorded on the landing pad by the mass of the box. Students will then compare the force recorded by the landing pad versus the prediction from extrapolation of the test data. Students will then discuss why their results either confirm or fail to confirm their prediction. Students will then write a conclusion about what engineers must consider in order to reduce the acceleration. What factors affect the acceleration of an object, and how are these related. Finally, what would they do to redesign the egg drop vehicle to improve results, and why.
Day 5:
Students will turn in write up over their egg drop project.

Students will retake the assessment that they took on day one. Scores will be compared to determine if there was any design challenge helped to better understand this concept.

Pre/Post Assessment for Egg Drop Project
1) What factors affect the acceleration of an object? Explain.

2) How are force and acceleration related? Explain.

3) Draw a graph showing the relationship between Force and mass. Place Force on the y-axis and mass on the x-axis.

4) Describe the mathematical relationship between mass and Force and acceleration.