An eggciting alternative to a science olympiad

by Patricia Doney

This is a new twist on a familiar Science Olympiad event. By combining two possible outcomes, it allows students to make choices in an inquiry format. Students must think about materials, Newton’s first and second laws of motion, kinetic energy, and acceleration. Prior to doing this activity, students need to understand the following physical science concepts: changes in speed and direction are indicative of acceleration, the relationship between the application of a force and the resulting change in position and motion on an object, and the important features of the process of scientific inquiry. This activity usually takes two days, one for design and practice and one for the actual dropping, and is a great lead-in or culminating activity for a unit on forces and motion. Groups should contain two to three students. This allows for input and participation by all members of the group. Too many students in one group may create gridlock in getting the design under way.

Advanced preparation

In advance of the lesson, teachers will have to find an area from which to drop eggs. This can be in a stairwell, off bleachers, out a second-story window, off a ladder, etc. Only one site is needed and the minimum height (depending on availability and teacher discretion) should be seven feet. Try to have an alternative drop site available in case circumstances change on the day of the drop. The site should also be out of the way where it will not disturb other teachers. Have a drop cloth or large piece of plastic to cover the landing area, a large garbage pail, and paper towels at the drop site. To complete the drop, you will also need a plumb line, metric ruler, and stopwatch.

Have construction materials ready on the day the activity begins so students can see what they will be using in their design (see Activity Worksheet). All eggs should be purchased by the teacher and be the same size and type. For example, all medium white eggs from one egg company. They won’t be exactly the same, but it will be pretty close. Be sure to include a few extra in case some are cracked in transporting them to school or during the time you are setting up for drop day. Discuss with students the following rules before beginning:

• Each team will be given only one egg and can use only 1 meter of tape and seven sheets of paper in their design. To keep all teams within the required
amount of materials, the teacher can have the measured tape and set of papers ready for each team in a container. If class time is 50 minutes, allow 20 minutes for design discussion and drawing, and 30 minutes for creating the design out of the paper and tape. This time can be adjusted for block scheduling and 90-minute classes. Do not hand out raw eggs until the actual drop time. We discuss the importance of design before any materials are handed out and the relationship of a good design to the idea of conservation of materials. Students get only one set of materials, so planning is crucial. Once the egg protectors are built, have students place them in their container with their team name and class period on the container. The teacher will collect materials at the end of the period and return them to students at the start of the next day’s class.

- It is the job of the team to keep the raw egg from cracking.
- The team may choose to protect the egg in one of three ways. They may choose to do so by attaching something to it. Using the materials, they can either devise a parachute to slow the egg down, wrap it in protective covering, or create a safe landing area. If the teams choose the third possibility, they must create a type of landing pad that will protect the raw uncovered egg when it hits the ground. The landing pad must be self-standing and nothing can be on the egg.
- They may not combine the three protection measures—they can use only one.
- Clay is good to use when students are practicing. Have students mass their egg and then mass an equal amount of clay. They can then form the clay into the shape of an egg and use the clay egg for practice drops. If the clay becomes dented during a drop, this indicates that a real egg would probably have broken, and that the team should consider modifying their protective measures. This also saves on the amount of eggs needed. During modification of the structure, the teacher can issue an additional half-meter of tape and two additional sheets of paper only after students show how they will use it in their modifications. This is the only time that additional materials will be issued.
- Team members may only touch their own eggs. The teacher is the only person who hands out the eggs to each team just prior to the drop. The day of the drop, the eggs can be left at room temperature. To make all variables equal, all eggs should be approximately the same temperature before the drop.

Once the egg hits the target, it can only be unwrapped by one of the team members. A judge (adult) must then

### FIGURE 1 Rubric

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Possible points</th>
<th>Self-evaluation</th>
<th>Total earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worked collaboratively.</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used only materials that were assigned.</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design demonstrated knowledge of Newton's Laws by correctly labeling friction forces, gravity forces, the mass of the object, and where the energy goes when it hits the ground. A short descriptive paragraph can be included in journal with the labeled picture.</td>
<td>20</td>
<td></td>
<td></td>
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<tr>
<td>Student demonstrated safety procedures.</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student demonstrated appropriate use of plumb line.</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student drew and labeled the points of kinetic and potential energy and included a short paragraph describing what would happen if the egg were released with additional downward force and why.</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final drawing and brief summary of what happened to the egg has been included.</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td></td>
<td></td>
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</tbody>
</table>
inspect the egg for cracks. A cracked egg is a disqualified egg. If the egg is not cracked, the team can then try dropping it from a higher location. All students within a class go through each round before moving to the next height if their egg hasn't broken. The teacher can choose to go up a foot or more at a time. If you are on a staircase, you can go up a landing at each interval, on a ladder you can move up three steps at a time, etc. Just keep it consistent for each class. All teams are responsible for cleaning up their mess directly after their egg is dropped. Use paper towels to scoop up cracked eggs and smooth out plastic over the landing area before the next group takes the ready position. Students must wash their hands after cleaning up the raw eggs.

**Conservation of materials and plumb line**

Before allowing teams to get their materials, have them discuss what their design will look like and then draw and label it in their notebooks. This “design stage” leads to conservation of materials and helps to keep the cost down. As they change their design during the building stage, have them redraw it in their notebooks so they can see a succession of ideas. Teachers will also have to give brief directions on how to use a plumb line. This is usually demonstrated on the day of the drop. A plumb line is just a string with a weight attached to one end. The string should be several feet long—long enough to reach the egg drop target from the height it is being dropped. Students lower the weighted end of the line until it reaches the landing target and then align the egg with the string. This will give them a starting position for their egg prior to dropping. The teacher can also measure the distance on the plumb line and mark the line with different colors to signify different heights. This will give everyone an equal starting place. The adult will then move the plumb line, and the egg will be aligned with the target and ready for the student to drop. If a plumb bob is not available, then you can tie on three to four washers, or any weight that will keep the string taut. To keep all variables equal, each student uses the same plumb line.

**Drop site**

All students must wear safety goggles, and sufficient space must be allowed between students and landing area so flying debris or splattering eggs do not get on students. I recommend a five-foot radius around the landing area. All students except the student dropping the egg should be on the lower area with an adult supervisor. Another adult supervisor needs to be on the upper level to help with plumb line and to ensure the safety of students leaning over safety rails to drop the egg. If there is no other adult available to help during the egg drop, then the teacher should remain on the upper level, unless a ladder is used.

Students on the lower level should be divided into three groups. These groups will change as each team drops their egg and rotates into a lower group when they have completed their drop. The groups are assigned the following jobs:

- **Timers**—Students time the drop from release to landing and then take the average time and report this to the recorders. The adult supervising this group can also keep time to compare with student findings.
- **Calculators**—Students calculate the speed by dividing distance over time.
- **Recorders**—These students have a list of students and their team name. They record the height at which the egg was dropped before it cracked and the speed it was traveling.

The entire procedure will take place as follows: Team 1 will begin the drop. Teams 2–5 are at the lower level timing, calculating, and recording. When Team 1 has completed their drop, they rotate into one of the recording groups and Team 2 rotates to the drop position. This continues through each drop level with each team whose egg has not broken until only one team remains or a tie has been called. Team standings can be posted at the completion of the exercise.

**Science concepts**

Kinetic energy results from motion and is equal to half the product of an object’s mass and the square of its velocity. The goal in this activity is to dissipate the energy of the falling egg to keep the egg from breaking once it hits the target. The structure built around the egg, or a landing pad, will absorb some of the energy on impact and keep the egg intact. Newton’s first law—a physical body will remain at rest, or continue to move at a constant velocity, unless an outside force acts upon it—can be used in conjunction with kinetic energy to explain the necessity for the dissipation of energy to lessen impact and keep the egg intact. If a parachute is attached to the egg and the forces acting upon an object are balanced, then the acceleration of that object will be 0m/s/s. If it is unbalanced, then acceleration will occur, changing its speed, direction, or both. Thus, the parachute becomes a viable option for slowing down the descent of the egg. Newton’s second
Activity Worksheet 1—Eggcitement

Materials (per team)
- 7 sheets of notebook paper
- 1 meter of masking tape
- scissors
- clay to equal the weight of the egg for practice.

Procedure
1. Working with your group, design your structure. Draw and label each part in your science notebook (include the material that will be used to construct that part).
2. Write a brief summary of how this design incorporates Newton’s laws and demonstrates knowledge of kinetic energy.
3. Discuss design with teacher and gather materials to build structure.
4. Perform trial runs using clay egg. Record height and test result along with any changes in design in your journal.
5. Draw and label each new design as changes are made to the structure with an explanation for the change.
6. Collaborate with teammate(s).
7. Learn to use a plumb line.

Data

<table>
<thead>
<tr>
<th>Tries</th>
<th>Mass of raw egg (g)</th>
<th>Mass of egg and/or protection (g)</th>
<th>Distance traveled (m)</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Practice 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final</td>
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law of motion states that the acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object. Force = mass × acceleration. This second law can be used to explain why the egg will slow with parachute attached. Newton’s first law (i.e., law of inertia) can also be used to aid students in understanding that the more weight their structures have, the harder it will be to slow them down (the greater the mass or velocity, the greater the inertia).

Post activity
During post-activity time, compare the most and least successful designs. Ask students how they would now redesign for better protection. Have them put a final drawing in their notebooks and write a brief summary of their final design and how it demonstrated knowledge of Newton’s laws and kinetic energy. Ask students to include an answer to the following: What changes did our team make? Why did we make those changes? What would we do differently next time? This gives students a visual representation of their thought progression and allows them time to be reflective. Students are assessed using the rubric provided (see Figure 1).

Additional suggestions
If students mass their eggs that have protective covering or their landing pads, this variable also lends itself to some very interesting post-activity discussions. Ask students if the amount of material used in the design made a difference in protecting the egg. Look at each design and discuss what part could be considered good protection and what needed to be improved. Ask students why they think some designs were more protective than others. Ask students what other variables besides design may have influenced the outcome. Include questions on whether or not speed could be determined with the information generated or if mass of the object made a difference in the amount of kinetic energy contained in the egg. As a “real-life” activity, students can place their egg in a toy car. A ramp (a wide wood plank) can be used with a block at the end that the car can crash into. Students can design safety devices to keep the egg (passenger) from getting injured.

This can be linked to lunar landings in the unit on planets. Students can design a chute that allows the egg to land on a target without cracking. The egg that comes closest to the target wins. Students can even design a mini Mars city around the landing pad and research what living on Mars would entail. The teacher can also show the relationship between inertia and gravity in orbiting satellites (Moon around the Earth, solar system around the Sun).

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