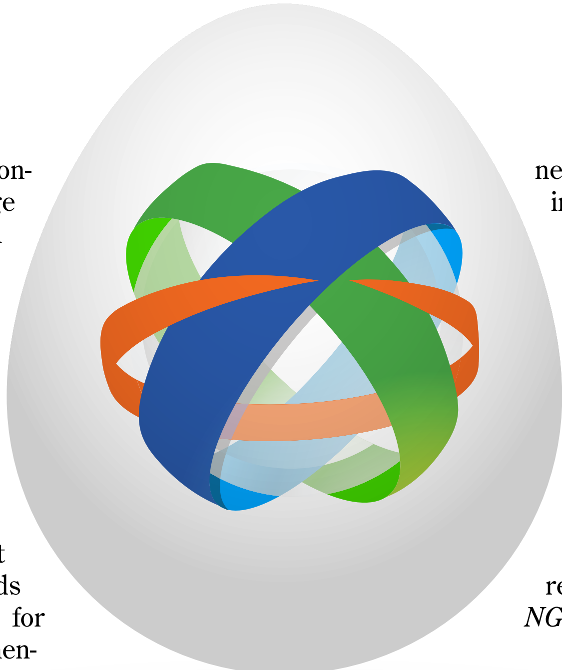
Evaluating the Egg Drop

Using the EQuIp Rubric to Ensure Activities Meet the *Next Generation Science Standards*

By Carolyn Higgins



The egg drop has been considered a rite of passage for many middle school students, mine included. As I transitioned to using the *Next Generation Science Standards* (*NGSS*) (NGSS Lead States 2013), I started looking critically at lessons and activities I used in my classroom to determine whether I could still use them. My priorities focused on building lessons that aligned with the new standards while ensuring sufficient time for students to engage in three-dimensional learning. Many resources that I had previously used did not fit the *NGSS*, but not all were tossed away. Instead, some were thoughtfully revised to align with the *NGSS* and became part of a sequence that built student understanding of a particular phenomenon.

For a number of years, my students finished the force unit with an egg drop project. I would give them a list of acceptable supplies and have them build their "Avian Protection Device" at home. There were criteria and constraints such as maximum mass and overall dimensions. Eggs were inspected prior to the drop and points were earned for eggs that survived the fall. It seemed like a great culminating project for our force unit. Then came the *NGSS*. I needed to develop a reason why anyone would drop an egg down the center of a stairwell. In reality, this activity was not connected to the real world in any way. But could it be?

The EQuIP Rubric can help evaluate a lesson or unit to determine its quality and potential effectiveness (see Resource). The rubric includes sections that determine the alignment to specific *NGSS* dimensions, the quality of instructional supports, and whether student progress is effectively monitored. The rubric can determine what is lacking in a resource. Using the rubric to evaluate my pre-*NGSS* version of the egg drop helped me to determine whether it was usable and what revisions were needed to make it *NGSS* aligned.

Planning the revision

Reviewing the pages of the *NGSS* with the egg drop activity in mind, I sought a specific performance expectation (PE) that it met. Because the PEs describe what students should know after instruction, one learning experience is not enough for students to reach a PE. Students need multiple learning experiences to build their understanding of each topic. The egg drop activity is part of a learning sequence that builds understanding. I reviewed the middle school standards and found potential disciplinary core ideas (DCIs), scientific and engineering practices (SEPs), and crosscutting concepts (CCs) to incorporate into a learning experience involving an egg drop.

To plan the activity details, I focused on engaging students in the *NGSS*'s three dimensions while they completed the activity. There were several disciplinary core ideas the activity could address. I considered the DCIs addressed during the "Relationships Among Forms of Energy" unit and determined the assignment would be part of students' understanding of DCI PS3.B: Conservation of Energy and Energy Transfer: "When the motion of an object changes, there are inevitably some other changes in energy at the same time" (NGSS Lead States 2013). As with any topic in *NGSS*, I planned a sequence of experiences for students to ultimately meet the DCI. For example, prior to building the egg drop container, students developed an understanding of the types of energy and evaluated energy conversions on a smaller scale by evaluating the sand displaced by falling objects. They investigated how energy can vary when they dropped a steel ball from a variety of heights into a container of sand. The ball created a larger/deeper dent in the sand when dropped from a higher distance. Then, they evaluated how balls of various mass dropped from the same height displaced the sand. The egg drop activity was the final activity in this sequence. In addition to providing a chance to assess student understanding of how changes in energy often accompany changes in motion, the egg drop activity also helped meet aspects of DCI ETS1.C: Optimizing the Design Solution. Specifically, it addressed the idea that "The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution" (NGSS Lead States 2013). In order to address this DCI, I scheduled adequate class time to test and modify the product.

Turning to the scientific and engineering practices, Constructing Explanations and Designing Solutions seemed to be the best fit for this activity. Students engage in multiple practices, but the activity and the assessment of their understanding focused on this SEP, especially the part that reads, "Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process, or system" (NGSS Lead States 2013). Finally, I determined the best crosscutting concept. The activity was about energy conversion, but I wanted the CC to have a wider lens than just energy. Since students engineer and test a tangible product, I chose to include the CC Structure and Function. The focus of analysis would engage students in determining how the structure of the chosen materials contributes to the function of the product they create.

The activity supports student learning of energy conversion and engineering optimization while they are engaged in designing a solution and developing conceptual understanding of how structure affects function. My *NGSS*-related planning allowed for opportunities to intertwine the dimensions as students worked. While planning the details of the activity, I kept the EQuIP Rubric handy, stopping at several points in the process to review the completed parts with the rubric to be sure I kept my focus.

My students engage well with classroom learning experiences that connect to real-world issues, so I thought of a need for which students could engineer a solution. Remote areas of the world often need medicine and vaccines delivered to assist humanitarian efforts. Drones were also making the news and seemed to interest my students. I decided to engage my students in engineering a shipping container for the World Health Organization. The container could protect glass vials of medicines that would be carried by drone to a remote area and dropped from a height of nine meters, which happened to be the same height as the open three-story stairwell in our school. Also, remote locations of the world need to receive vials in biodegradable packaging because there is no waste system for synthetic materials. Eggs would be used as a stand-in for the glass vials during the engineering process. If the egg remained intact while testing the engineered package, then the vials would most likely survive the drop as well. I found online videos of delivery drone prototypes to engage my students in the idea and allow them to see what drones are capable of.

Putting it into motion

Because this activity was part of a sequence, it was purposely completed after students met the needs of performance expectations MS-PS3-1 and MS-PS3-2. Students had previously engaged in the iterative engineering design process, so they understood that design and testing is not a "one and done" type of activity. They knew the importance of evaluating and revising a design to develop the best product.

Day 1

Engaging students in the activity was a success. Students were intrigued by the use of drones and were eager to start designing. Setting the criteria to make the containers biodegradable made the designs much more creative than previous years when students had included bubble wrap and packing peanuts. This time, the structure of the container would be as important as the materials.

The class brainstormed possible materials that were biodegradable. They created a list of possible materials and I agreed to supply most, but other materials could be brought from home. Student groups of two or three reviewed the student information (available at *www.nsta.org/middleschool/connections.aspx*) and began planning prototypes. Students made lists of materials that they needed from home.

Days 2–4

I allowed three days of class time to design and build the prototypes. Students had access to the stairwell to test their iterations, but no eggs were allowed to be on board. Several students brought egg-sized rocks to class to be the "passenger." A number of teams stayed after school to work, determined to meet the criteria and have a successful product. Even my most academically resistant student was engaged; all loved the project's problem-solving nature and the autonomy to make it their own. After the prototypes were built, teams were required to draw a labeled diagram of their prototype and list the materials used in the final product. Each student also had to write a preliminary explanation of how the kinetic energy that the container had at the time it reached the floor would convert to other forms of energy without affecting the eggshell.

Day 5

The day before we dropped the containers, students participated in a gallery walk and each team had two to three minutes to show its prototype and diagram to the class. Teams also read their explanation of the intended energy conversions. Students were very proud of their work.

Day 6

On the drop day, students were eager to test their designs. A large X was taped to the floor at the bottom of the stairwell and the entire area was covered with a transparent plastic drop cloth. Students safely observed each container drop from the stairwell, standing along the rails. A vast majority of the eggs survived the nine-meter fall. Students with cracked eggs were accepting and began to consider ways to improve their design to make it successful.

Day 7

Students began writing an explanation of the energy conversion and an analysis of how each material in the structure contributed to the container's function to protect the contents. Students reviewed the diagrams and initial explanations that were still on display throughout the room. This reflection allowed them to revise their original ideas and build on them. Only part of their grade was determined by the condition of the egg after the fall, and they had an opportunity to recover the lost points by describing why it failed and how the design could be improved. The analysis was written in class with each student submitting his or her own original work. Students were encouraged to use text and online resources to research other materials or structures that could have been used in their design.

Assessing the results

The *NGSS* have altered the way I assess student learning. Instead of testing my students on facts or details of concepts with an on-demand assessment, I now incorporate the assessment into the process. I have always used formative assessments but not to the extent that I do with the *NGSS*. I give each student a weekly participation grade, assessing responses when I check in with student teams while they work and their engagement in class discussions throughout the process. I assess each student individually on his or her participation in the group. By visiting the groups and observing as an outsider, I can see the dynamics of the group. Although each student might not contribute the same type of work, I look for each student to be pushing himself or herself to learn and collaborate with the others.

Students' summative grades on this activity were based on a combination of the container meeting all criteria and constraints, the condition of the egg after falling, and the written analysis. The analysis required students to respond to prompts regarding the energy conversion and the structure and function of the parts of their container design. My students were encouraged to edit work to show a better understanding and resubmit to improve their grades; most followed through on this.

With the *NGSS*, students are given multiple opportunities to engage in the ideas that lead to proficiency in each PE. The result of my revision of the classic egg drop activity works to engage my students in three-dimensional learning and deepen their understanding of science. (For another three-dimensional take on this classic activity, turn to page 62.) Since implementing the *NGSS* in my classroom, I have seen an increase in engagement with all learners. From the highest achievers to the students who need support, the *NGSS* seems to be a positive influence on their understanding of the natural and designed world. ■

Reference

NGSS Lead States. 2013. *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press. *www.nextgenscience.org*.

Resource

EQuIP Rubric—*www.nextgenscience.org/sites/default/files/EQuIP%20Rubric%20for%20Science%20v2.pdf*

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