

Save the 'Ulu

Investigating Forces within Engineering Design

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Grade Level	6th – 8th Grade	**Time Frame**	180
Subject	Science	**Duration**	3-4 periods

Essential Question

Can modern science explain cultural fables or legends? How do you know when you have considered all possibilities before building a solution to a problem?

Summary

This lesson encourages students to use their knowledge of forces to design an effective parachute. This is a more culturally aware, process-focused version of the classic "egg drop" concept, using a Hawaiian fable to inspire the engineering design process.

Snapshot

Engage

Students read a story about solving a problem.

Explore

Students identify engineering design process steps embedded in the story.

Explain 1

Students discuss the engineering design process elements and come to a consensus about them as they are represented in the story.

Extend 1

Students rotate through stations to determine the best parameters for a parachute.

Explain 2

Students use their data to draw a blueprint of their “best” parachute to bring the 'ulu fruit safely to the ground.

Extend 2

Students build the parachute and test it three times.

Evaluate

Students assess their design and speculate on adjustments needed.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD302: Understand basic scientific terminology
SIN401: Understand a simple experimental design
SIN403: Identify a control in an experiment
SIN503: Determine the experimental conditions that would produce specified results
SIN601: Determine the hypothesis for an experiment
EMI404: Identify similarities and differences between models
EMI503: Identify the strengths and weaknesses of models

Next Generation Science Standards (Grades 6, 7, 8)

MS-PS2-2: 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.
MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Oklahoma Academic Standards (8th Grade)

8.PS2.2 : 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.

Attachments

- Engineering Design Process—Save the Ulu - Spanish.docx
- Engineering Design Process—Save the Ulu - Spanish.pdf
- Engineering Design Process—Save the Ulu.docx
- Engineering Design Process—Save the Ulu.pdf
- Kai-ulani and Kekahu Make Pancakes-Play—Save the Ulu - Spanish.docx
- Kai-ulani and Kekahu Make Pancakes-Play—Save the Ulu - Spanish.pdf
- Kai-ulani and Kekahu Make Pancakes-Play—Save the Ulu.docx
- Kai-ulani and Kekahu Make Pancakes-Play—Save the Ulu.pdf
- Kai-ulani and Kekahu Make Pancakes-Short Story—Save the Ulu - Spanish.docx
- Kai-ulani and Kekahu Make Pancakes-Short Story—Save the Ulu - Spanish.pdf
- Kai-ulani and Kekahu Make Pancakes-Short Story—Save the Ulu.docx
- Kai-ulani and Kekahu Make Pancakes-Short Story—Save the Ulu.pdf
- Lesson Slides—Save the Ulu.pptx
- Station Set Up Guide—Save the Ulu.docx
- Station Set Up Guide—Save the Ulu.pdf

Materials

- Lesson Slides (attached)
- “Kai'ulani and Kekahu Make Pancakes” Short Story (attached; one per student)
- “Kai'ulani and Kekahu Make Pancakes” Play (attached; one per student)
- Engineering Design Process handout (attached; one per student)
- Station Set Up Guide (attached)
- Station supplies (see Station Set Up Guide for specific quantities of each material)
    - Cord or string
    - Fabric
    - Paper (paper bag-style works well)
    - Plastic (plastic bag-style works well)
- Large binder clips
- Meter sticks

- 'Ulu fruit or ball of similar size
- Any materials that could be used to make parachute baskets
- Pencil or pen

15 minutes

Engage

Teacher's Note: Choosing Between Two Story Formats

There are two attachments for the story used in this lesson: one is a short story and the other is a play. Choose the format best suited to your students and print out a copy for everyone before beginning this lesson.

In both versions, reference is made to the Hawai'i Space Exploration Analog and Simulation Site, an isolated research station site on the Mauna Loa side of the saddle area on the Big Island of Hawaii.

When students enter the classroom, pass out the attached story "**Kai'ulani and Kekahu Make Pancakes**" in either **Short Story** or **Play** format. After students complete their first read-through, have them share out what they feel the story was about.

Next, introduce students to the rest of the lesson using the attached **Lesson Slides**. Display **slide 3** and go over the essential questions. Display **slide 4** and go over the lesson objectives.

If needed as an additional resource, display **slide 5** to show students a photograph of 'ulu fruit and **slide 6** to show a video of 'ulu fruit being harvested.

Teacher's Note: Searching for 'Ulu

If you search '*ulu* on the internet, many of the top sites will describe a type of knife used by Inuit, Yupik, and Aleut women. However, the 'ulu that is relevant to this lesson is the Hawaiian word for "breadfruit." Use *'ulu fruit* or *breadfruit* in research queries.

The 'ulu tree is considered sacred in Hawaiian folklore. For more information on this legend, "The Gift of Ku," check out this website that explores tales and myths associated with trees: Spirit of Trees.

Move to **slide 7** and introduce the Think-Pair-Share strategy. Have students read the story a second time. Instruct them to annotate or highlight the text to respond the following prompt: *Based on the reading, identify the five steps of the engineering design process that the characters follow to solve their problem.*

After students have read the passage, have them pair up and compare their notes to see how similar or different their steps are. Invite a few students to share what they discussed with their partner with the class.

20 minutes

Explore

Teacher's Note: Handout or Notebook?

If you use an interactive notebook in your curriculum, the handout may or may not be required. You may pass out a copy of the entire handout to each student, or you may prefer to copy-paste and/or print only the parts of the handout you think they need (the constraints and data tables). To scaffold student learning, use your judgment to determine how much—or little—of the handout is needed.

Pass out the **Engineering Design Process** handout. This will be used throughout the lesson.

Assign students to groups of two or three. Have them work collaboratively to complete Part 1 on steps of the engineering design process.

Instruct them to use textual evidence from the story to identify the steps that Kai'ulani and Kekahu use to bring down the 'ulu fruit safely from the tree. If there are disagreements, have students use evidence to argue their claim and reach a consensus.

15 minutes

Explain 1

When the groups have completed Part 1 of the handout, discuss with the whole class how each group identified the steps.

Before moving on to the next step, take time to clarify any misconceptions the groups may have expressed.

Tell students that over the next few days, they will test different types of parachutes, just as Kai'ulani and Kekahu do in the story, to determine the best design to bring down the 'ulu fruit safely.

Display **slide 8.** Review the model of the engineering design process with the whole class.

Move to **slide 9**. Have students use the Claim, Evidence, and Reasoning (CER) strategy to hypothesize what type of parachute will be the optimal design to get the 'ulu fruit safely down from the tree.

Teacher's Note: Pacing

Depending on how long it takes to read the story, this may be the right time to pause and pick up the next day. The next activity will take at least one full class period, and materials will need to be prepared for the stations.

60 minutes

Extend 1

Teacher's Note: Preparation

Set-up is required for this section. It can be prepared the day before.

Set up stations on different tables. The supplies needed for each station are included in the **Station Set Up Guide**. (Depending on student numbers and supply access, you may have multiple tables of the same station.)

Station 1: For the independent variable, provide three different canopy sizes (small, medium, and large). As controls, keep the suspension length and canopy material all the same.

Station 2: For the independent variable, provide three different canopy materials (paper, plastic, and fabric). As controls, keep the suspension length and the canopy size all the same.

Station 3: For the independent variable, provide three different suspension lengths (short, medium, long). As controls, keep the canopy material and canopy size all the same.

Tell students they will use the engineering design process. Instruct students to use the “Parachute Testing Stations” section of the handout to record their observations.

Assign students to work in pairs to test the different canopy materials, canopy size, and suspension length.

Tell them that throughout the trials, they will use the same drop height (3 meters) and suspension load (large binder clip) standard in every station and trial. Remind them they will be comparing the results for the time it takes the large binder clip to hit the ground.

Display **slide 10.** Review the definitions for independent variable, dependent variable, and control variable.

Before students start each station, remind them to make a hypothesis and determine the following:

- independent variable
- dependent variable
- control variables

Remind students that, as they progress through the stations, they should record their observations about how the different variables affect the results.

Display **slide 11.** Review with the whole class what they will be testing at each station. Assign pairs to their first station. Instruct them to move in station number order. Clarify that they can progress to any station next but must visit each station until they have completed all trials.

Teacher’s Note: Checking in with Students

While students are testing at each station, use this time to check in with every group. Make sure they are collecting data congruent with that station and understanding the purpose of each station.

25 minutes

Explain 2

When students are done testing at each station, have them stay in pairs and use their findings to come up with a blueprint for what they think is the best parachute design for Kai'ulani and Kekahu.

Have students create their design under the “Blueprint” section of the handout they already have. Remind them that a variable that must be included in their design is the testing ball or 'ulu fruit. Provide students with a ball or 'ulu fruit to use for their parachute blueprint and design.

Optional Activity to Increase Difficulty

You may want to add an assignment that requires students to create a budget for their projects. Advise them that as they create a blueprint, they will need to consider all constraints and requirements of the lesson. One of the constraints of the lesson is that all items cost money. Tell them that the budget for each project is a maximum of $20. Provide students with a price list and remind them that they cannot exceed the budget.

25 minutes

Extend 2

Teacher's Note: Building the Parachute

Provide extra parachute materials at the three stations, as well as materials that can be used for their baskets.

After students have completed their planning and have created their blueprints, instruct them to build the parachute they planned.

Display **slide 12.** Give students time to build their parachutes from their designs.

Once the parachutes have been built, have students test them by dropping their 'ulu fruit or testing ball off a balcony (or similarly high location somewhere around the school) three times.

Remind all members of the group to make and record their observations after each drop under the “Build and Test” section of the handout. Remind the groups to drop the parachutes from the same height each time.

10 minutes

Evaluate

Display **slide 13**. To guide students in evaluating their design based on their results, have students fill out the “Assess and Reflect” section of the handout.

Invite students to use the Claim, Evidence, Reasoning (CER) strategy to write a statement on the optimal parachute design to get the 'ulu fruit safely down from the tree. After students write their CER statements, ask them to reflect on their designs and describe what they would change if they had the opportunity for an additional design phase.

Resources

- HIHomegrown. (2011, September 5). *Breadfruit harvest tool* [Video]. YouTube. https://www.youtube.com/watch?v=6ZQaRVdQ66Q
- K20 Center. (n.d.). Claim, evidence, reasoning (CER). Strategies. https://learn.k20center.ou.edu/strategy/156
- K20 Center. (n.d.). Think-pair-share. Strategies. https://learn.k20center.ou.edu/strategy/139
- Loebel-Fried, C. (n.d.). *The gift of ku*. Spirit of Trees. https://spiritoftrees.org/the-gift-of-ku
- McMillan, V. (2010, March 27). *Breadfruit* [Image]. Flickr. https://www.flickr.com/photos/27614859@N04/4481426425
- The STEMAZing Project. (n.d.). *Engineering design process, adapted from the UA College of Engineering*. The STEMAZing Project for the Office of the Pima County School Superintendent. https://stemazing.org/engineering-design-process-university-of-arizona/