KENAN FELLOWS PROGRAM
FOR TEACHER LEADERSHIP

STEM Forces and Motion Hoop Glider

OVERVIEW

Students will explore the concepts of testing, variations, and variables through the construction of a hoop glider and participation in a competition to see which team can build a glider that will glide the farthest before touching the ground.

AUTHOR	GRADE LEVEL	CONTENT AREA
Thomas House	5-6	Design and Modelling

ESSENTIAL QUESTIONS	TIME NEEDED	STANDARDS NC Standard 5.P.1
How do planes fly? Who were the Wright Brothers? What do engineers do? What do planes, birds, and gliders all have in common that make them fly? What is a variable? What are the variables in this experiment? What is a test in an experiment? What is variation in an experiment?	Setup time: 10 to15 minutes Activity Time:30-40 Minutes Wrap up/ review time: 10 to15 minutes Total lesson time: 50-60 minutes	Understand force, motion and the relationship between them. 5.P.1.1 Explain how factors such as gravity, friction, and change in mass affect the motion of objects. 5.P.1.2 Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel. 5.P.1.3 Illustrate the motion of an object using a graph to show a change in position over a period of time. 5.P.1.4 Predict the effect of a given force or a change in mass on the motion of an object.

Making **Connections**

Students should think about things that glide and consider the physical make-up of objects such as hang gliders, kites, airplanes and even birds. They should think about the Wright Brothers and what early planes looked like. They can consider incorporating elements of those objects that they hypothesize will increase their own hoop glider's flight distance.

Background

In this lesson, students will learn about what makes planes, gliders, birds, and other objects fly. They will also discover what an engineer does and what it takes to be an engineer. Students will learn about the engineering design process through familiar subjects such as the Wright Brothers and searching the Smithsonian Air and Space Museum's website. They will make a real-world connection by designing their own glider using the information from their research.

Materials

- Paper strips (2): 1 inch wide and 5 inches long; 1 inch wide and 10 inches long
- Ruler
- Scissors
- Pencil
- Nonbendable, plastic drinking straws
- Tape
- Miscellaneous materials such as: aluminum foil, strips of manila file folders, etc.

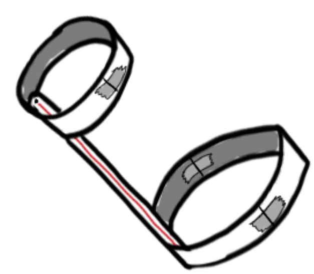
Teacher **Tips**

Ask students to think about things that glide and to consider the physical make-up of objects such as hang gliders, kites, airplanes and even birds. Encourage them to consider incorporating elements that they hypothesize will increase their hoop glider's flight distance.

The **Activity**

1. Start with a review of the engineering design process using familiar objects. This is where they will get their background knowledge. See the "Resources" portion of this lesson for helpful research websites and materials.
2. Next, ask the essential questions to get the students thinking about prior knowledge, and how they can test their design.
3. Now, give detailed instructions on how to build the initial glider:

- Cut the index card or stiff paper into 3 separate pieces that measure 1 inch by 5 inches.
- Take 2 of the pieces of paper and tape them together into a hoop as shown. Be sure to overlap the pieces about half an inch so that they keep a nice round shape once taped.
- Use the last strip of paper to make a smaller hoop, overlapping the edges a bit like before.
- Tape the paper loops to the ends of the straw as shown below. (notice that the straw is lined up on the inside of the loops)
- That's it! Now hold the straw in the middle with the hoops on top and throw it in the air similar to how you might throw a dart angled slightly up. With some practice you can get it to go farther than many paper airplanes.



4. Now that the glider is finished, we are going to change a few variables (one at a time) and see what impacts they have.
5. Instruct students to complete the appropriate data table for each test.

Test 1: Test the initial design first, then make a new glider and change the length of the straw. You can cut the straws or attach straws together for this test.

Test 2: Go back to your initial design. Change the number of hoops. Start with a completed glider and add or take away hoops as directed in the table below.

Test 3: Go back to your initial design or make a new one if necessary. Change the layout of the hoops on the straw so they aren't lined up.

WRAP UP **AND** ACTION

After the students finalize the three tests and answer the associated questions, help lead a class discussion about what the groups found as a result of the experiments. Students who finish early can begin the extension activity so everyone will be busy leading up to the discussion.

The discussion should cover these points:

- It may look weird, but you will discover it flies surprisingly well.
- The two sizes of hoops help to keep the straw balanced as it flies.
- The big hoop creates "drag" (or air resistance) which helps keep the straw level while the smaller hoop in at the front keeps your super hooper from turning off course.
- Some have asked why the plane does not turn over since the hoops are heavier than the straw. Since objects of different weight generally fall at the same speed, the hoop will keep its "upright" position.

After the discussion, use a short exit ticket to assess student learning. Questions could be follow-ups to the testing like:

1. How did the length of the straw impact flight distance? Why?
2. How did the number of hoops impact the flight? Why?
3. How does the layout of the hoops impact the flight?
4. What variables did you change in this experiment?

Extensions

Ask students to explore Engineering: Go For It - Aerospace and preview the two videos on the site. Ask students to answer some of these questions:

1. What are some other areas where aerospace engineers use their skills outside of building planes and rockets?
2. Many of the new aircrafts that aerospace engineers design make use of lightweight composite materials. Why?
3. Where are some places that an aerospace engineer might work (including GE Aviation)?
4. Where did Neal Saiki work before creating Zero motorcycles?
5. What is the NASA Puffin designed to do?

Resources

Kindergarteners Are Born Engineers

ThinkTV | David and Kayleen Design a Glider - For younger students (K-2), nice short video for less developed readers..

PBS Learning: Aerospace Engineering - These resources are extensive, but geared towards grade 6 and above.

Engineering: Go For It - Aerospace Engineers

More Aerospace Activities and Lessons from Glenn Space Center

STEM-Pack Aerospace Engineering from the American Association of University Women

Aerospace Micr-lessons from the AIAA (American Institute of Aeronautics and Astronautics)

Smithsonian Air and Space Museum

About the **Authors**

Thomas House is a 2019-20 Kenan Fellow. House teaches in Asheville City Schools.

About the **Fellowship**

As a WNC Kenan STEMwork Fellow, Thomas House participates in a three-week internship with GE Aviation. Along with other WNC STEMwork Fellows, he worked to develop a deeper understanding of the industries located throughout Western North Carolina, their workforce needs, and how K-12 educators can make relevant connections for their students.

Student **Pages**

Test 1:

Test the initial design first, then make a new glider and change the length of the straw. You can cut the straws or attach straws together for this test.

Design	.Length of Straw	Flight Distance

Question: How does the length of the straw affect flight distance?

Test 2:

Go back to your initial design. Change the number of hoops. Start with a completed glider and add or take away hoops as directed in the table below.

	# of Small Hoops	# of Large Hoops	Total # of Hoops	Flight Distance
Remove a Hoop				
Add 1 Hoop				
Add 2 Hoops				
Add 3 Hoops				

Question: How did the change affect how far the plane flew?

Test 3:

Go back to your initial design or make a new one if necessary. Change the layout of the hoops on the straw so that they are not lined up.

Question: How does this affect how well the plane flies?