HEY BERNOULLI...
NEED A LIFT?

GRADES 3–6

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OVERVIEW:

The purpose of this lesson is to demonstrate how Bernoulli's principle creates lift, enabling objects that are heavier than air to fly.

ITV SERIES:

Dr. Dad's Ph^3: Flight

LEARNING OBJECTIVES:

The students will learn that:

- ❖ In order to get an object that is heavier than air to fly, you must create lift.
- ❖ Lift can be created by changing the angle of attack of an airfoil.
- ❖ Bernoulli's principle uses the shape of a wing's surface to create lift.
- ❖ The same principles that get a wing to fly also work in things like kites, frisbees and boomerangs.

VOCABULARY

velocity
gravity
Bernoulli's principle
lift
angle of attack

MATERIALS:

PER STUDENT:

- a square of corrugated cardboard from an old box approximately 12" x 12"
- a large lump of plastic modeling clay or play dough
- a pencil
- a good pair of scissors

PRE-VIEWING ACTIVITIES:

Introduce the topic of heavier than air flight by assembling a collection of flying objects such as a kite, a frisbee, a boomerang, some model gliders, etc. Begin the discussion by asking the students where they think the idea of flight got started. Undoubtedly, the concept came from people watching birds in flight.

Ask the students to define what the word flight actually means. Basically, flight means that something has to be able to take off and land in a controlled manner. Have them list things that fly. Certain animals (insects, bats and birds) fly using muscles and wings. Balloons and air ships fly because they are less dense than air, so they are buoyant and can float up and down. (see Dr. Dad's Ph^3 program on Gas Laws). Airplanes fly because they have engines and wings. Rockets fly because they have a tremendous amount of thrust.

Take the class out to a large ball field or borrow the use of the gymnasium for the day. Have them experiment with the frisbees, kites and gliders to see what factors control how the device flies. Can a frisbee fly without spinning? Why must you run with a kite? Will a kite fly without a tail? Allow them to collect as much data as possible. Then come back to the classroom and share their ideas.

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FOCUS FOR VIEWING:

Explain that in order to accomplish flight, all of these things must somehow balance forces. A force is either a push or a pull and in the case of airplanes, the most important force is gravity. To overcome gravity, a plane must have lift, and the lift comes from the wings.

To get that lift, most airplanes use a concept called Bernoulli's principle. In the case of an airplane wing, the curved upper surface causes the air flowing over the top of the wing to be thinned out a little. This reduces the pressure above the wing and air flowing in from underneath lifts the plane off the ground.

Hold up each of the flying objects you have brought in and ask the students to describe what features they have in common. (They all have broad flat surfaces that tend to be curved on top.) Ask them to think about how these surfaces work to counteract the force of gravity and invite them to watch the video.

VIEWING ACTIVITIES:

Start the video and **pause** immediately after the girls ask Dr. Dad why an airplane wing must be curved on the top. Have the students offer some suggestions and then **continue** the tape.

Pause the tape again when Dr. Dad demonstrates Bernoulli's principle with the hair dryer and ball. If possible, bring in a hair dryer and, using an inflated round balloon, allow several student volunteers to recreate the demo. See if they can develop some type of rule concerning how changing the angle of the air flow changes the way the balloon moves. **Resume** the tape and watch the section on the class and their homemade plane.

Stop the tape after the elementary school piece and review how the angle of attack and Bernoulli's principle help to keep a plane up. Explain to the class that while most people don't realize it, a boomerang is really a type of wing (airfoil) that uses the same principles of aerodynamics to stay aloft. In a simple airfoil, lift is achieved by the shape of the object, its angle of attack and the thrust behind it In order to keep a boomerang stable, you must be able to balance the forces acting on it. This is done by distributing the mass and shaping the wing.

Give each student a pre-cut piece of cardboard and have them draw the outline of a boomerang on it. They can either draw a standard boomerang design or they can create their own design. The important point is that the design should be symmetrical.

Have them cut out the boomerang from the cardboard and try flying it by grasping one end and throwing it in a tomahawk type motion. (Note: This activity is best conducted near a large open field or in a gym where kids have room to move.) What are the results?

Give each student a lump of modeling clay and have them spread it across the upper surface of the boomerang. Have them test the boomerang for balance and stability by flying it with the clay on top. By re-working and shaping the clay, they should be able to sustain longer and longer flights. If time permits, have them try some different boomerang designs and compare the results. Does any one style of boomerang consistently fly farther? Can any of the students get their boomerang to return?

Return to the classroom and discuss the outcome of the boomerang experiment. Then **start** the tape and continue viewing the rest of the video.

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POST-VIEWING ACTIVITIES:

Have the students review the general principles of flight. Review how the aerelons and elevators control the pitch and yaw of the plane and how Bernoulli's principle and angle of attack help keep it up.

ACTION PLAN:

Have the students take Olivia's Challenge. Give each student a standard 8 1/2" x 11" sheet of paper and have them construct a simple glider. By folding one side of a sheet of paper over on itself several times they can create an airfoil. Have them test different designs to see which one consistently flies further.

Invite an engineering student or pilot to come in and discuss the practical aspects of airplane design with the students. Have them research if there are any new designs or materials being used today that will radically change the airplanes of tomorrow.

In the development of airplanes many different designs have been tried, including planes with circular wings, flat wings, swept wings and even no wings! Obviously some of these designs never got off the ground, but many helped scientists and engineers re-think the ways that planes could be built. Research some of the great successes and flops in aviation history and if possible, draw a picture or make a model.

EXTENSIONS:

SOCIAL STUDIES:

While the Wright Flyer gets a great deal of "press" as being the first true airplane, it was not solely an American invention. Many people from different countries worked on the development of the airplane, including individuals from France, Great Britain, Germany and Italy. Check out who some of these aviation architects were and research what contributions they made to the science of aeronautics.