Activity: Flight - How an Airplane Wing Works

Grade Level(s)	Timeframe
6-8	30 - 60 min

ABSTRACT

When I learned to fly in a University Air Squadron in UK in the 1970s, they told us that the Bernoulli Principle explains how an airplane wing works. We now know that that is not true. I am sure it contributes a little, because we know that the pressure on the top side of the wing is lower. But the main explanation is Newton's Third Law.

The lesson finishes with making paper airplanes, so kids can experiment with control surfaces before the next lesson.

This is lesson 2 of 3 in Don's Flight series,

EXTRA FILES

011_2.docx
011_3.pdf
011_4.pdf
011_5.jpg

SUPPLIES AND EQUIPMENT

- Paper for airplanes.

GETTING READY

The paper about how an airplane wing works shows the shape a wing would need if it relied on Bernoulli alone. It is way too thick! It would result in too much drag, and we would not a much more powerful engine (providing more thrust) to compensate for the high drag. This would be very inefficient.

Engineers don't wait to find out exactly why something works. We enjoy learning why, but we don't wait for the perfect explanation. We describe the ways it works, usually using

math. We do experiments and make equations that match the experiments, and use those equations to design airplanes and other things.

I show 2 model airplanes and a model helicopter (quadcopter).

I follow the following outline:

1. Forces acting on an airplane: lift, gravity, thrust, drag (la portance, le poids ou la gravité, la poussée, la traînée)

2. Newton's 3 Laws of Motion

3. How an airplane wing creates lift, from Newton's Third Law. The wing pushes down on the ambient air, so the air pushes up on the wing.

Then I quiz them on what we talked about. Then we make paper airplanes. (We need sheets of paper.) I suggest that during COVID, we should not fly the planes at school. Each student can take their plane home and fly it at home.

We review the forces acting on the paper airplane: lift, drag and gravity. Thrust is provided by the muscles in their arms because there is no engine.

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From the EIR Discord:

DonB — 02/25/2023

In the 1970's (seems so long ago now), I was a grad student in England. Being Canadian, I could apply to join the University Air Squadron. To my delight, I was accepted! This meant that I was part of the Royal Air Force Voluntary Reserve. On free afternoons and weekends, I could take a train to a nearby airfield and learn to fly! These photos show me in uniform

and beside the Chipmunk trainer aircraft. (The Chipmunk was designed and built by Dehavilland Canada.) They taught us that the lift force of the wings is explained by the Bernoulli Principle.

About ten years ago, a grade 6 teacher asked me how to explain the lift force of wings. She said that the Bernoulli Principle is no longer accepted as the explanation for the lift force. I did some research and found this article:

http://www.aviation-history.com/theory/lift.htm

It debunks the common Bernoulli Principle theory and shows that Newton's Third Law of Motion is a better intuitive explanation. Now when I teach Flight in grade 6, I use some of the thinking of this article.

It is clear why fixed wing aircraft must keep flying to maintain lift. If they fly too slow, there is insufficient lift and the airplane stalls and drops quickly. I have a model quadcopter (a drone without a video camera). It is like a helicopter, or rotary wing aircraft. This type of aircraft can hover with zero airspeed, because the rotors, which are like wings, keep moving. You can look at the edge of the quadcopter rotors. It is obvious that they push the air down as they rotate. If you make the quadcopter hover, the students know that they would feel air flowing downward if they put their hand under the quadcopter, so the air pushes the aircraft upward, following Newton's Third Law.

In Bob Thomas' series of videos about Control Surfaces of airplanes, he shows that if both elevators (horizontal surface of the tail) are bent up, the airplane climbs (because there is less lift or even negative lift in the tail so the nose goes up). Climbing without an engine causes the plane to lose speed. Therefore, the plane stalls, and falls to the Earth.

This shows that when a pilot climbs in a fixed wing aircraft, the engine must be at full throttle, to prevent a stall and crash.