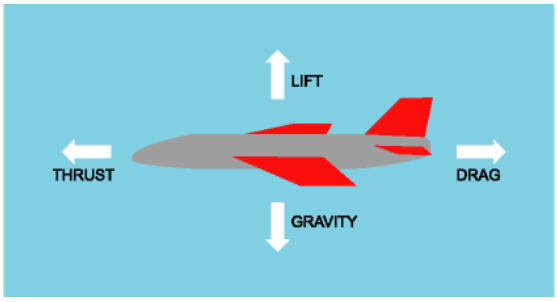
Lesson Plan: How to Fly
Berkley Maynard Academy (Thurs)

Materials (assuming 5 groups of 5):
6 Taketombo rotors
10 sheets of paper (More?)
Scissors, paper clips (plenty)
Cobra, Dragon, and Nick's Airplane Instructions
(Helicopter optional unless Taketombo are missing)
Instant/fast wood glue for the rotors (optional)

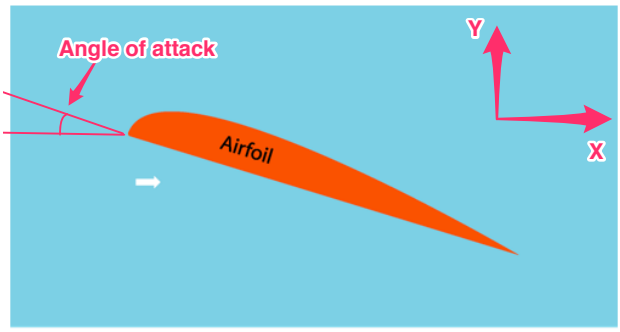
Teaching Plan:
Students will get to see the principles of aerodynamics in action! We will be using the Taketombo's and paper airplanes to illustrate the ideas of lift and thrust. There will be a airplane throwing competition to see whose airplanes can go the furthest. This lesson plan will emphasize engineering design!

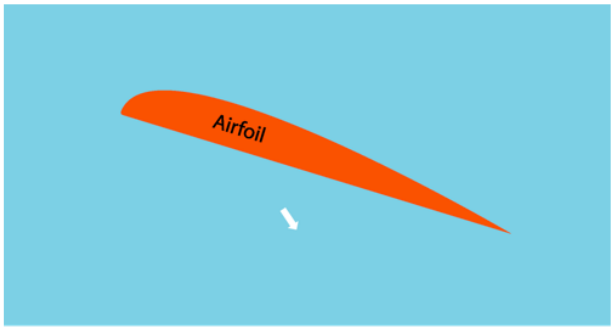
Scientific Background (for mentors):



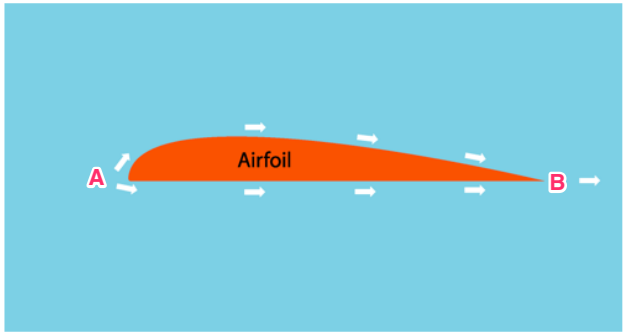
The figure on the left covers the four important considerations for flight. To sustain and control flight, the airplane must attain and maintain an amount of lift and thrust greater than gravity and drag, respectively.

The most important consideration for understanding flight is lift, which allows the plane to stay airborne. There are two ways to explain lift – in terms of [1] Newtonian physics (Newton's 3rd Law) and [2] fluid dynamics (Bernoulli's Principle).





[1] Newton's 3rd Law states that "For every action, there is an equal and opposite reaction." Using this concept, when the air hits the airfoil (a cross section of airplane wings) it creates a force that has components in the X and Y axes. This resulting force in the Y axis is the lift force, accelerating the airfoil and the wing upwards. The Newtonian Lift, which is explained here, scales depending on the sine of the angle of attack; if the angle of attack were 0, then the Newtonian lift would be zero as well.



[2] The alternative explanation comes from Bernoulli's Principle. The basic assumption we make in this explanation is that the air presses equally on all sides of the object. Building on this assumption, refer to the diagram depicting a flow of air over an airfoil with the angle of attack = 0 on the left. The airfoil shape causes the air to go farther over the top of the wing than under the bottom, both in the same amount in time. Therefore, the upstream air is moving faster which thereby reduces the pressure above the airfoil. This difference in pressure causes lift.

The rotor blades on the Taketombo's and the wings on the paper airplanes attain lift in these ways; however, it'll probably be easier to visualize Newtonian lift for the mentees.

Agenda:

1. Introduction to flight (15 mins)
2. Introducing airplane designs, introducing challenge (5 mins)
3. Split kids off into groups, fold airplanes (35 mins)
4. Go outside, throw airplanes! (~25 mins)
5. Taketombo Introduction, Wrap-up (~5 mins)
6. Final assessment (~10 mins)
    a. Label the airplanes they made: locations of lift, thrust, and balance

Tentative Activity Layout:
Ask about what flying is, and ask them to list what flies.

Lead a discussion on what makes an airplane fly – engines, fuselage, wing flaps
Connect to paper airplanes – low weight (gravity) and the source of thrust (push from hand/arm)

Introduce airplane designs brought to class: the Cobra, the Dragon, and Nick's. Engineering design and teamwork: announce the challenge. Prize: Mentor-made airplanes!

Put the kids into groups, each group with three templates. Have mentors ready to help – but let them fold their own planes.

After the time is up, go outside to throw airplanes: we will have two competitions – one for distance and one for the longest flight time. Remind them to behave in order to win the prize! (The prize is a professionally crafted, masterful paper airplane made by a mentor.)

Closing Activity, Discussion:
Discuss what affected the reach of the airplanes.

- Why did some airplanes hit the ground faster? (They're all the same weight!)
- Why didn't many of the airplanes follow a straight path?
- Did the amount of thrust put in the airplane affect its flight distance?
- Why are real airplanes not made of paper?

References:
Taketombo: www.dealextreme.com/p/46079
Flight information, pictures: www.funpaperairplanes.com/Learn%20About%20Flight.html
Airplane designs: www.paperairplanes.co.uk/
Possible future project: www.dealextreme.com/p/43820