Air-mazing Experiment
Grade 6 Academic Lesson #1

Topic: air pressure (science, language arts)

Length of Lesson: 30 minutes

Lesson Reference: Steven Spangler One Breath Bernoulli Bag

Objectives:

- Students will make predictions and use critical thinking skills.
- Students will see Bernoulli's principle in action.
- Students will illustrate the movement of air molecules.
- Students will explain Bernoulli's principle.

Next Generation Science Standards:

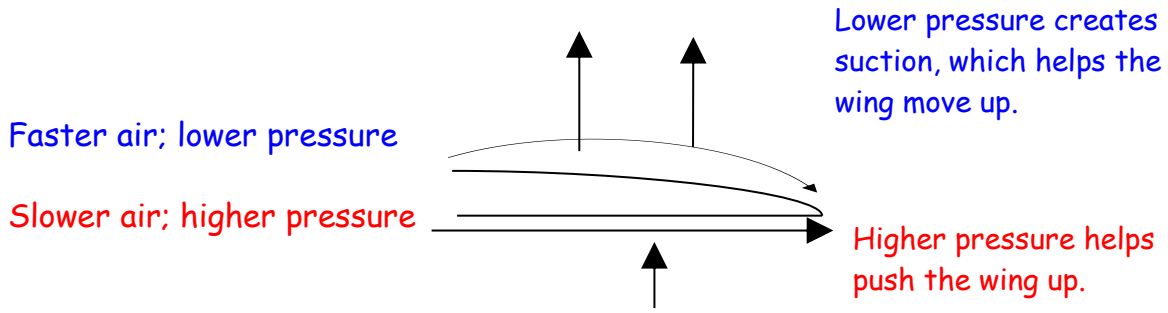
- MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

CCSS ELA:

- SL 6.4 - Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
- L 6.6 - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level.

Background Information:

In the early 1700s, Daniel Bernoulli (pronounced "burr-new-lee") determined that faster moving air has a lower pressure than slower moving air. Slow moving air has a higher pressure. The lower pressure creates a suction effect while the higher pressure results in a push. This helps to explain in part why the wings of an airplane lift into the air. Air moves faster over the top of the wing than air moving underneath the wing; therefore, there is a "push" occurring underneath the wing while there is a "pull" above the wing. (Angle of attack, or the orientation of the wings to the air, is also responsible for lift.) Find more information at NASA: Bernoulli's Equation.



NOTE: Before conducting this experiment in front of the class, view a video of the Bernoulli bag (windbag) demonstration "Windbags: Cool Science Experiment" or Bernoulli's Principle Demonstration: Bag. Then, practice blowing up the bag with one breath to be ready to "wow" the class with such "magic!"

Materials:

- 2 Bernoulli bags (provided by CAP for 6th grade ACE teachers; purchased from Steven Spangler Science, but also available at teacher stores)
- notebook paper and pencil
- dry-erase board/chalkboard and marker/chalk

Lesson Presentation:

1. Tie a knot in one end of the windbags; using them as props to start the lesson.

2. Explain to students that a person called a "windbag" is a person who talks and talks, barely taking a breath! Such a person would be said to have good lungs and lots of air power.

3. Tell the students that not everyone with good lungs or lots of air power is a "windbag." People with good lungs are usually healthy and good athletes. Ask for a volunteer who feels he/she has enough air power to blow up one of the windbags you have in a very few breaths. Have the volunteer come to the front of the room.

4. Using one windbag, you should hold the end with the knot and ask the student volunteer to hold the open end of the bag. You two should spread apart so the windbag is fully extended in front of the class. Then, ask the class how many breaths they think it will take the student volunteer to fully inflate the windbag. Listen to student predictions. (You may want to write them on the board or screen.)

5. Tell the class that when we make a hypothesis (an educated guess), as we obtain additional data (information), we may change our hypothesis. Tell the class that they will begin to obtain some data to test their predictions.

6. Direct the student volunteer to hold the bag around his/her mouth and blow directly into the bag as strongly as he/she can for 5 breaths; closing and holding the opening after each breath.

Closing the opening of the bag after blowing in it each time will keep the air from escaping while taking the next breath. After 5 breaths, use your hand to slide down the windbag, pushing the air in the bag all the way to the knotted end of the student's bag. Ask the other students if they want to change their hypothesis about the number of breaths it will take to inflate the bag now that they have some new information. Listen to new predictions. Then, push all of the air out of the bag by sliding your hand toward the open end of the bag.

7. Tell the volunteer that you want to have a race with him/her to see who can blow up the bag the fastest and with the least number of breaths. Take the second windbag and invite two other students to come to the front of the room to hold the end of the windbags for you and the first student volunteer. Ask the students holding the "knot" end of each windbag to count the number of breaths of air that are blown into the windbags. Tell the student volunteer you are racing that you will give him/her a head start. Conduct a class countdown and begin!

8. Once the student volunteer has started blowing into the bag, stand about 10 inches away from the opening of your bag, take a deep breath (just one breath!), and blow into the bag. Students will be surprised to see your windbag "magically" fill up using only one breath of air! Quickly trap the air in the bag by grasping and closing the open end of the bag after you see it inflate.

9. Ask students if they can explain what happened. Listen to their guesses and then explain to them that you created a stream of fast moving air from your lips that was directed toward the center of the opening of the bag. The slower moving air molecules surrounding the faster moving air molecules had a higher pressure; thus, the higher pressure pushed air molecules outside the wind bag toward the lower pressure center that the individual created by blowing into the bag from several inches away. Faster moving air has a lower pressure than air moving slowly. Low pressure creates a suction-like effect, so the lower pressure helped pull in other surrounding air molecules outside the bag, which helped to fill the bag quickly. High pressure follows low pressure. Tell students that this information about air pressure was discovered by scientist Daniel Bernoulli in 1739, and this information became known as Bernoulli's principle: faster moving air has a lower pressure than slow moving air. The student who held the wind bag directly to his/her mouth cut off the supply of all air molecules outside the bag. Explain that you chose to utilize the air molecules outside the wind bag by using your knowledge of Bernoulli's principle.

10. Ask students if they can think of practical applications for this information. In other words, why would it be important to know Bernoulli's principle? Explain that in weather, areas of high pressure follow low pressure. Also, with hurricanes, a pressure that is falling means the intensity of the hurricane is increasing. Another way to put this information to good use is using it to remove smoke from a room or building. If there was a major cooking accident in your kitchen that resulted in the kitchen being filled with smoke, you should leave space between the door

leading outside and a fan to help remove the smoke. Firefighters refer to this technique as "Positive Air Flow."

Finally, Bernoulli's principle helps explain how an airplane flies. Use the background information to explain how Bernoulli's principle helps an airplane stay aloft.

11. Ask students to draw the windbag experiment to illustrate what is happening with the air and pressure. Underneath their picture, ask them to explain Bernoulli's principle.

12. Invite a volunteer to share his/her drawing and explanation with the class. Ask the volunteer to draw his/her picture on the board. Confirm correct ideas and redirect incorrect drawings or explanations.

Summarization:
Ask students what they learned today. Review Bernoulli's principle. Ask students to explain how Bernoulli's principle relates to lift for an airplane.

Character Connection: Tell students that in life, we experience a kind of pressure that seems to push or pull us in different directions. Remind students that despite the pressure that may come from others, they need to stand strong and do what is right. Just like the fast moving air energized the slower moving air and helped to pull the air into the windbag, encourage the students to create a kind of positive pressure that helps energize their peers to move in the right direction and make good decisions.

Ask students to recall the amount of time it took to inflate the wind bag when you utilized air molecules outside the bag by using your knowledge of Bernoulli's principle. It took much less time and effort to fully inflate the wind bag compared to the student who was trying to inflate the bag using only the air molecules generated from himself/herself. Point out to the students that when you obtain help, you can usually get a job done faster. When you try to do big jobs on your own, it can be extremely time-consuming and difficult. Just like the slow moving air being helped along by the fast moving air, teams of people working together get jobs done more quickly and efficiently and quickly. Encourage students to be team players and help one another.

Assessment:
- teacher observation
- student answers to class discussion questions
- student pictures and written explanations

Additional activity ideas to enrich and extend the primary lesson (optional):

- Have small groups of students research other ways to demonstrate Bernoulli's principle using Air & Lift: The Bernoulli Effect or some other reliable source. Instruct each small group to

practice their presentation and demonstration skills until they feel confident enough to video their presentation as a teaching tool for future classes. Compile several of the groups' video demonstrations into one tutorial to be published on TeacherTube.com.

- Have students use the steps of the scientific process to write about the windbag experiment.

- Discuss moral integrity. (Moral integrity is doing the right thing when no one is watching. Knowing what is right and wrong is easy. Doing what is right, even when it is not easy to do so involved moral integrity.) Have students create short stories or skits to demonstrate how forming and pursuing goals and maintaining high moral integrity can overcome negative peer pressure.

- Allow students to create an illustration to help explain why an airplane is able to fly through the air.