CaSTL

Bernoulli - Air Pressure Lesson

Boys and Girls Club After School Science
CaSTL program at UC Irvine

Lesson Objective: Children will understand the concept of Bernoulli's Principle in cooperative groups and by making observations and talking to their partners to notice patterns of air currents that determine the differences in air pressure and motion of common objects. The overall goal of the lesson is to help students understand how Bernoulli's Principle can be used to understand how the design of airplane wings and rear car spoilers utilize differences in air speed to create higher and lower air pressure (can use running water of the tap against backside of spoon to illustrate Bernoulli's principle.)

Materials Used: Newton Anti-Gravity Puzzle, Ping Pong Balls, Funnels, Letter Size Plain Paper, Balloons and Strings

Student Talk Strategies: *Report to a Partner, Revoicing*

Classroom Management: CHAMPs

Conversation: Children may talk with inside voice to their partners only. **Help:** If children need help, one of the group will raise a hand to let the teacher know. **Activity:** Children will use manipulatives, make observations, and draw the materials and movement of forces/pressure that they see. **Movement:** Children will stay at their place. **Participation:** All children in the group are expected to take turns and handle the manipulatives.

ENGAGE: ***Connect to Prior Knowledge and Experience, Create Emotionally Safe Learning Environment, Preview New Vocabulary*** **Estimated time: 10 minutes**		
Teacher's Role	**Teacher Questions**	**Children's Role**
1. Teacher Presents students with Newton Anti-Gravity puzzle with task of removing wooden red plug. 2. Teacher has pairs report out. Teacher records findings on chart paper- using drawings and words.	1. Report to a partner: Ask your elbow partner, "How can we get the red plug out of the wooden cup without touching either the plug or the cup with any part of our body?" 2. Was your solution correct? Did it meet the requirements and restrictions set forth by the puzzle?	1. Children respond individually by talking to an elbow partner. **Novel Solutions:** Some children may come up with the idea of blowing the cup on its side until it moves and falls over the side of the table. This may be possible, but reassert to the student that the wooden cup must remain where it is on the table and the table itself can not be tilted or turned over upside down.

2. Teacher asks for volunteers to propose solutions or demonstrate ideas on how to remove the red plug from the wooden cup.	2. The teacher can give clues to the solution such as "we do this every second and if we were to stop doing this we would die."	2. The students with these clues should be able to come up with the idea of breathing or air and using puffs of air to help get the red plug out of the cup.
3. Teacher has volunteers to come up to demonstrate how blowing forcefully on top of the cup can push the red plug out of the cup. If students cannot blow with enough force, then the teacher can demonstrate this in front of whole class.	3. Ask students why they think that blowing air forcefully on top/across the top of the cup can help to force the red plug out of the cup.	3. Students may come up with the idea that there is a gap between the cup and the plug that allows air to go in-between and under the plug which pushes under the plug to push it out, but the correct explanation and biggest contributing factor is the Bernoulli Principle.
4. Teacher uses a large, poster-sized paper / white board to draw out the vertical cut slice of the puzzle showing what students think is happening and then showing exactly what is actually happening with the cup/plug puzzle when air is blown across it. See attached worksheet and directions pages.	4. If there is time in the lesson, the teacher should ask students leading questions/questions that ask students to think critically and explain based upon scientific principles or logic the basis of what is happening with the phenomena they are seeing.	4. The teacher explains the Bernoulli Principle by showing with fists/hands pushing against each other. This relates back to the push/pull lesson with forces. One hand/fist is pushing down. The other is pushing up. When the top force (air particles) is pushed away from the top of the plug (the top hand/fist is moved away), the bottom hand/fist remains and pushes up on the plug. Bernoulli's principle specifically states that any time there is an area of faster moving air, that area has reduced air pressure. The opposing/other side has higher air pressured and pushes against the surface with increased pressure.

<table>
<tr><th colspan="3">EXPLORE: Hands-On Learning, Contextualize Language, Use of Scaffolding (Graphic Organizers, Thinking Maps, Cooperative Learning), Use of Multiple Intelligences, Check for Understanding Estimated time: 20-30 minutes</th></tr>
<tr>
<td>1. Teacher sets up 2 to 3 stations depending on time and number of students:
Station 1) Funnel Station (Each student is given their own funnel that can be made from a clean plastic water bottle cut in half). Students will predict first what will happen when they blow up into the funnel with the ping pong ball inside the funnel and then again with the funnel upside down with the ping pong ball in the funnel.

Station 2: Paper station: Students will fold letter size paper in half to form a tent. Students will predict what will happen to the tent when air is blown inside the tent. Students will have a letter size paper spanning most of its length across two books forming a bridge. Students will blow air underneath the bridge but before doing so they will predict what will happen to the piece of paper and explain why it will behave the way they predicted.
Students will also take a letter size paper and hold it at the shorter end between their fingers. They will place the paper close to their mouths above their chin and blow air across the top of the paper. Before doing so they will predict what will happen to the piece of paper.</td>
<td>Station 1: Predict what will happen to the ping pong ball when we blow with the funnel up: will it stay where it is? Go flying up out of the funnel? Or will it do something else? Please explain why this will happen. (There is a worksheet with questions on this station that the students can fill out during this part of the lesson.) Record your observations and after talking to your partner try to explain what happens.

Station 2: Predict what will happen to the paper tent/ flat sheet of paper between the two books/sheet of paper held by your hand close to your mouth. Will it go up? Will it stay where it is? Go down/collapse? Or will it do something else? Please explain why this will happen. Record your observations and after talking to your partner try to explain what happens.

Station 3: Predict what will happen when we blow air between the balloons: Will the balloons go apart? Stay where they are or come together? Record your observations and after talking to your partner try to explain what happens.</td>
<td>Station 1: The ping pong ball when the funnel is up will stay where it is. It may move around or rattle a bit in the funnel but will not fly up as predicted by most students as this is the seemingly logical and scientific answer. Bernoulli's principle states that fast moving air lowers the air pressure on the side where the air is moving faster. In the case where the air is blown up into the funnel the faster air is below the ball. As air enters the funnel from below, it moves around the ball lowering the air pressure beneath it. There is still air pressure from above the ball that is greater which pushes down on the ball and forces the ball to stay inside the funnel. The set up is reversed when the funnel is upside down but the explanation based upon Bernoulli's Principle is the same. Target and repeat the concept asking students to determine where the air is faster. Once they determine that fact they can correctly predict what will happen in that phenomenon.

Station 2: The fast moving air below the paper tent will create lower pressure below the tent and higher pressure above so the tent will collapse a little bit.
Blowing air across the top of the paper creates lower pressure above the paper and</td>
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<tr><td>Station 3: Balloon Station: Two regular balloons blown to approximately 3 to 4 inches will be placed about 2 inches apart and hung by strings attached to their tied openings. Students will predict what will happen to the balloons when they blow air (slower and faster) and then will blow air between the two balloon</td><td></td><td>higher pressure below so the higher pressure will push the paper up.

Station 3: The balloons come together because the air is faster between the balloons, lowering the air pressure between the balloons. Greater air pressure on the side / outside of the balloons pushes the balloons together.</td></tr>
<tr><td colspan="3">EXPLAIN: Listening, Speaking, Reading, and Writing to Communicate Conceptual Understanding Estimated time: 10 minutes</td></tr>
<tr><td>Teacher's Role</td><td>Teacher Questions</td><td>Children's Role</td></tr>
<tr><td>1. Teacher tells groups to share their observations and findings. Relate the findings back to the predictions.

2. Teacher listens to groups' reports and repeats or Revoices (one of the five productive talk moves) what they say to be sure that the class is noticing patterns and the learning is addressing the standards.

3. The explanation part is mostly performed during the exploration at each station. If the lead teacher/helper has not explained why the events are occurring the way they are at each station, then a classroom discussion and explanation of the ideas can be done after groups have made their rotation. The Bernoulli concepts of each station can be briefly reviewed and reinforced at the end of the lesson if time</td><td>1. Each group will now tell us what they observed. Was your prediction correct?

2. What evidence do you have to make that statement?</td><td>1. Children in their groups tell the whole class what they observed.

2. Students connect their exploration back to their predictions.</td></tr>
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permits.		

EVALUATE: ***Thinking Maps, Summarize Lesson and Review Vocabulary, Variety of Assessment Tools, Games to Show Understanding*** **Estimated time: 10 minutes**

Teacher's Role	Teacher Questions	Children's Role
1. Teacher asks students their prediction of what will happen in the thread spool and pin/circular paper demo (see attached handouts flyers) when we blow air into the spool from below and from above.	1. Teacher asks each student their predictions with a show of hands: Will the paper fly up or stay where it is? When blowing down on the spool ask will the paper fall down or stay where it is? Following the demonstration or before, ask a volunteer to explain why they made their prediction or explain what was happening to the paper when air was flowing through it and the paper based upon Bernoulli's principle.	1. Children decide whether the paper circle will stay or move away from the spool. They vote. Students observe and reflect on their prediction and observation of the results drawing what happens in a picture to the paper and spool.

EXTEND: ***Group Projects, Plays, Murals, Songs, Connections to Real World, Connections to Other Curricular Areas*** **Estimated time: 5 minutes**

Teacher's Role	Teacher Questions	Children's Role
1. Teacher connects the lesson to the real world explaining how airplane and rotor wing design as well as rear car spoilers use differences in air speed to utilize Bernoulli's Principle to fly or help racing cars/tires to stay on the ground. 2. The Bernoulli Bag demo/challenge can also be shown to students if time permits. 3. Also Bernoulli's Principle can be applied not only to air but to water/fluids as well. If there is access to a faucet, the	1. When you leave the classroom, notice the objects and people around you. What forces do you think are acting on them? 2. Students try to fill an 8 foot long plastic bag (Diaper Genie bag) with only 1 exhaled breath of air. 3. Students should predict whether the spoon should move toward the flowing water, away from the flowing water, or not move at all.	1. Children notice objects and people around them. They note the forces they think are acting on these. 2. Most students will try to fill the bag by placing the bag closely to their mouths to form a tight seal so no air can escape but the correct method to fill the entire bag is to leave a small gap between the bag and their mouth. The differential in air pressure from air being blown in the center (faster moving air) causes a difference in air

top handle of a spoon can be held loosely between the thumb and forefinger so that the curved back of the spoon slightly touches the surface of a fairly steady moving stream of water from the faucet. Students should make a prediction before this experiment is actually performed. Students should try this with a slower flow versus a faster flow of water to see any differences on the movement of the spoon.	Students should also predict what kind of effect faster flowing water will have on the spoon.	pressure with greater air pressure from outside the bag pushing a much greater volume of air into the bag. (This may be the physics behind the Dyson Airblade fans that work so well to move large amounts of air within a room.) 3. The spoon should move towards the water/away from them because the faster moving water lowers the pressure on the curved side (convex side) of the spoon. The greater air pressure on the concave side pushes against the spoon moving it toward the stream of flowing water. The faster the flow/moving water the higher the spoon should lift "up" and away from the student.

Student Talk Strategies

Adapted from *Avenues* (2007). Hampton Brown.

Design	Description	Benefits and Purposes
Report to a partner	• Each student reports his/her own answer to a peer. • The students listen to their partner's response. ("Turn to a partner on your left." "Now turn to a partner on your right" etc.)	• This allows students to talk to different students in the class and gives each student an opportunity to share and listen to various answers and language structures. • Talking one-on-one with a variety of partners gives risk free fluency practice. • Students practice speaking and listening.