



AND THEY TOOK A DEEP BREATH!

As children grow older, they try to make sense of their world in a variety of ways. Some of their understanding develops as a result of their own observations; things they overhear their parents or other family members say; conversations with friends; and their exposure to popular media. Teachers and textbooks also add to a child's repertoire of knowledge. However, often, the understanding children develop through their real-world experiences is different from what they learn in the classroom. School education rarely addresses these dual, parallel understandings.

We developed a module on respiration to identify student conceptions, and use these as the base to build a better understanding of the concept. The teacher started the class by asking students to take a couple of deep breaths. After some initial hesitation, the children played along.

"Do we breathe air or oxygen?" she asked them.

The class responded with a resounding answer. *"Oxygen"*, they said.

She asked, *"But, last year, we learnt that air is a mixture of many gases, right? So, how do we breathe just oxygen then?"*

This puzzled the children. After brief thought, one student responded, *"The hair in our nose helps us to separate oxygen from air"*.

Another student responded, *"But oxygen is much smaller. The hair inside the nose traps only large particles."*

Both had reasons for believing what they did. They started building hypotheses about how we could breathe just oxygen from the mixture of gases in the air. Many students supported each perspective. This resulted in an argument, with each side offering examples and counterexamples. It was a pleasure to see the students thinking, arguing and, most importantly, being engaged in a scientific discussion — an opportunity that seldom arises in conventional teaching.

At this point, a girl who had remained silent throughout raised her hand, and said, *"But pure oxygen is flammable. If we breathe in pure oxygen, won't there be a fire inside us?"*

Another student pointed out that *"If we could purify air and breathe just oxygen, we wouldn't need to wear pollution masks, and the problem of air pollution would have been solved!"*



Instead of just throwing facts at her students, the teacher led students through more detailed observations and thought experiments to test their hypotheses. For example, to address the hypothesis that the nose could filter oxygen from the mixture of gases in air, the teacher shared an image of the inner part of the nose. This showed the absence of the physical apparatus for such a filter. The teacher also took the opportunity to point out the need to revise or modify our hypotheses when our observations and the results of our experiments don't match it. After much deliberation and with the help of their teacher, the children arrived at the conclusion that we inhale air, and not just oxygen.

After this intense discussion, the teacher allowed the class some time to settle down. Then she asked them the next question, "How do you think we breathe?"

Interestingly, most students believed that our nose has a muscle that helps us suck air. Smiling gently, the teacher asked them to observe their breathing more carefully and record their observations. A few students said that they had observed their chest expanding. Others shared that they could feel the cold air gushing in through their nose. A few students remarked on how their nose muscles did not seem to move much during the process of breathing. Everyone seemed puzzled about how we inhale and exhale so much air.

"What is regulating this?" the teacher asked again.

There was much discussion amongst the students, but they could not arrive at an answer. Sensing the frustration

building up in the classroom, the teacher reminded them about a recently learnt chapter on wind. "Do you remember how wind moves?" she asked.

Many students quickly shared responses to suggest that wind moved from "high pressure to low pressure".

"Right! Now can you think of a mechanism for breathing?" the teacher asked.

"Yes!" a student responded with excitement. "When the pressure outside is high, air will go into our body. And when the pressure outside is low, air will rush out."

His friend immediately contradicted this, "How can pressure around us change every few seconds?"

"What do you all think?" asked the teacher, looking around the class. Seeing the class re-engage in spirited discussion, she beamed with joy.

After pondering on the teacher's question for a while, one of the boys suggested that, "The pressure inside our body changes. That will help to push and pull air."

The class was now close to finding out the actual mechanism behind breathing. Through an experiment using two balloons connected to each other with a T-joint enclosed in an empty bottle, and an elastic to pull its base, they quickly figured out how pressure inside a cavity can change. Together, they finally deconstructed the mechanism of breathing. Happy with this, they took a deep breath.



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