

Everest Education Expedition Curriculum

Classroom Activity: Research Gear and Equipment

Using a Pulse Oximeter



Created by Montana State University Extended University and Montana NSF EPSCoR
www.montana.edu/everest

Note: This activity requires your classroom to purchase or borrow a fingertip pulse oximeter.

Background information.

A pulse oximeter (pronounced *ox-IM-uh-ter*, also called pulse ox) is a small device that measures the level of oxygen in the blood (oxygen saturation). The fingertip-sized device is sometimes nicknamed a "walnut."

Low oxygen levels can indicate a health problem. Pilots or climbers at high elevation (where oxygen levels are lower) will also show reduced oxygen levels in their blood.

When climbers are at high altitude, there is much less oxygen available for them to breathe. Climbers on Mount Everest often use a pulse oximeter to monitor their oxygen levels and help determine whether they have a health issue or simply are breathing in lower levels of oxygen. As climbers go higher and all the way to the summit, their oxygen saturation levels will continue to decrease.

Climbers on their way to Mount Everest take time to acclimate, which means giving their bodies time to adjust to breathing less oxygen. It could take several weeks for someone who lives in Montana (approximately 3,000 to 7,000 feet; 900 to 2100m) to get used to being higher than 13,000 feet (approx. 4000m) or higher.

The measurement from the pulse oximeter is called oxygen saturation (listed as SpO₂%), and it maxes at 100%. The closer to 100% the better (although oddly, a reading of 100% can be an indicator of carbon monoxide poisoning!) Most healthy people at a relatively low elevation will have a reading of 95% or higher. Climbers at high elevation (such as on Everest) may see their readings dip in to the 80's—or even the 60's, as was the case for some of the Everest Education Expedition climbers!

People in a low-oxygen environment (such as at high altitude or in a room without enough air to breathe) will have lower readings. During vigorous exercise, oxygen saturation readings will also be generally lower as the body fights to drive oxygen to the blood.

About the device (*Note: The following instructions refer to the Roscoe Medical Finger Pulse Oximeter Product No. RMI-POX2D, which was included in Montana teacher kits. However, instructions will apply to many other similar devices, as well*)

A fingertip pulse oximeter is placed on a fingertip and takes just moments to get the measurements. It is non-invasive and totally safe. It will fit a child as well as an adult.

Remove the device carefully from the box. Do NOT open it all the way as you would open a stapler to put in new staples. It is designed to stay in a "folded" position. Add batteries if they are not already inside. Place your fingertip all the way into the device (you will be able to feel the back of the chamber as you put your finger all the way in). Press the raised button to activate the oximeter. Don't press too hard. You might let the child press it himself/herself. When you press the button a second time, the reading "flips" so that you can see it yourself (as opposed to it being turned away from you) If the monitor reads "finger out" it doesn't mean take your finger out; it just means it is not sensing your finger and you need to readjust.

You will see the numbers varying for a little bit until the measurement settles (generally) at two numbers: one is your pulse (standard heart rate, listed as PRbpm) and the other is the oxygen saturation rate (listed as SpO₂%).

The numbers will be hard to see for a big group, so you might consider using an ELMO-style projector if you can, so students can see the results. While readings may vary somewhat based on a child's overall fitness level, the numbers that come up should not be embarrassing to a child in any way. Different students will just have different numbers. The oxygen saturation rate will probably vary only between about 96 and 99 percent. Pulse rate will have a wider variation.

Activity

- 1) Show the class the pulse oximeter and explain what it is and what it measures. (or, show the class and let them think about what it is and what it measures)
- 2) Tell the class that climbers on Mount Everest sometimes carry a pulse oximeter to help them measure whether their oxygen levels are so low that they need medical help. Help students understand that higher elevations have less available oxygen.
- 3) Help the students measure their own oxygen saturation levels using the pulse oximeter. (It may take up to one minute for each reading, so you may want to choose a few volunteers)
- 4) Discuss why a person might have a reading that is higher or lower than others. Think about conditions that might cause oxygen levels to be higher or lower in the blood (vigorous exercise vs. light exercise vs. resting; general fitness level; caffeine and stress raise the heart rate, which will cause the oximeter reading to lower; some people just have naturally different rates)
- 5) Encourage the class to brainstorm some measurements they could take over time and under different conditions that might affect the pulse oximeter readings. (For instance, they could compare readings before, after and during exercise. Students can also take deep breaths or breathe into a paper bag. Sucking on a piece of chocolate will also cause the readings to change).
- 6) Discuss career, professional or recreational situations in which the pulse oximeter would be helpful to make someone aware of health conditions.
- 7) Students can ask family members if they have ever been measured with a pulse oximeter in a healthcare setting.

Going beyond

- Lesson 1 of the Everest Education Expedition Curriculum, "Who's On Top?" includes physiology-related activities and information, including Conrad Anker's training regime

and a classroom activity that helps students simulate what it feels like to hike at high altitude. See <http://www.montana.edu/everest/resources/index.htm>

- Ask some from the healthcare field to visit your class and talk about how he/she uses a pulse oximeter at work.
- Make a graph of a person's pulse oximeter readings over time
- Discuss hypoxia (lack of oxygen) and what happens physiologically to a person when s/he is deprived of oxygen
- Review the data of three climbers who summited Mount Everest <http://www.pbs.org/wgbh/nova/everest/expeditions/97/testresults.html> How do their pulse oximeter readings and pulse rate compare? Graph their oxygen saturation levels as compared to altitude.
- The Mayo Clinic is working with the U.S. military to better understand how a sudden change in elevation impacts a person's health. For instance, a soldier who is called up from sea level to a battle high in the mountains might experience altitude sickness and thus be unable to work. By using pulse oximeters to study oxygen saturation, the researchers may be able to suggest treatments and strategies for this situation.

Resources

MSU Science Zone #30: Can humans survive at high altitudes?

<http://eu.montana.edu/pdf/outreach/msuscizone30.pdf>

How a pulse oximeter works (with diagrams)

http://www.howequipmentworks.com/physics/respi_measurements/oxygen/oximeter/pulse_oximeter.html