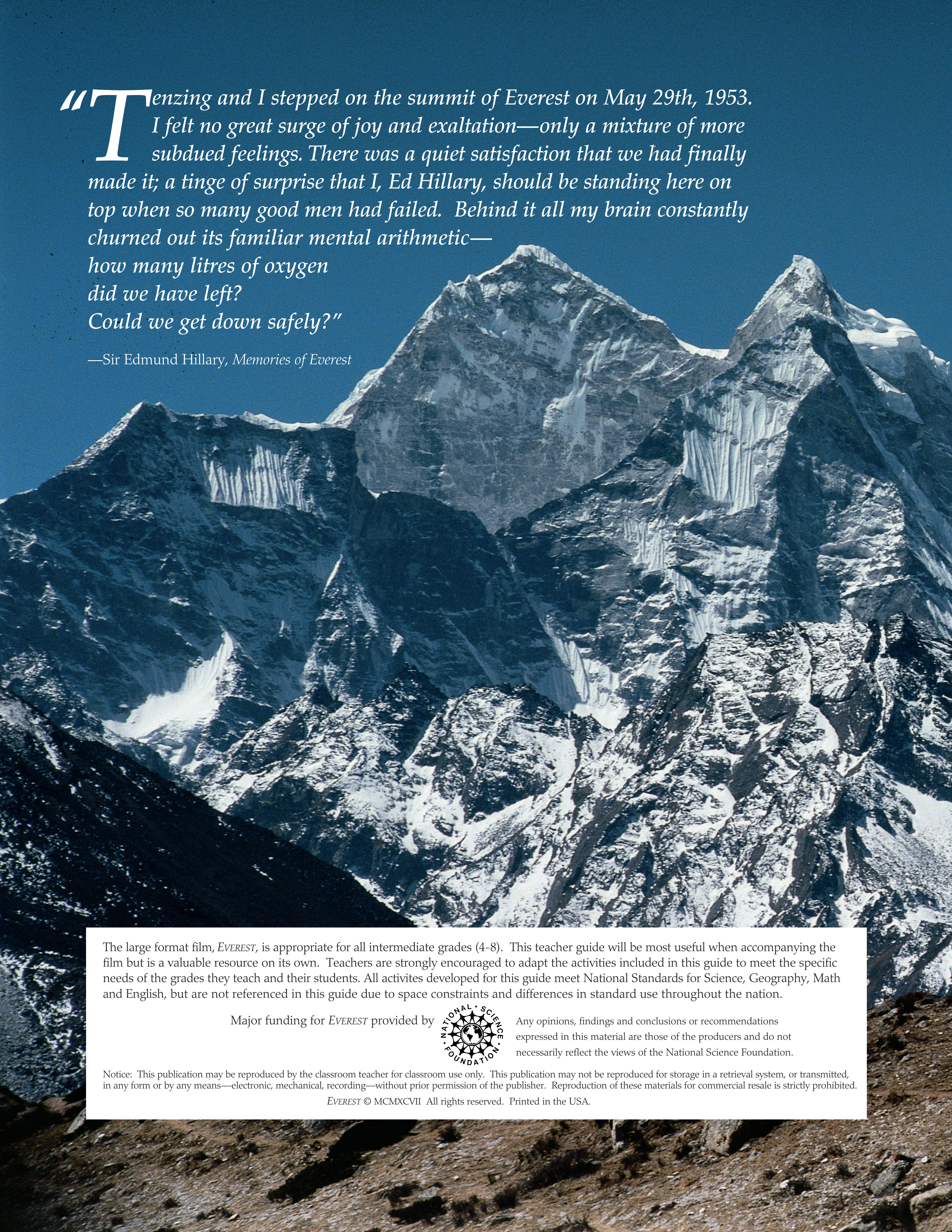
TEACHER'S GUIDE

MACGILLIVRAY FREEMAN'S EVEREST



"Tenzing and I stepped on the summit of Everest on May 29th, 1953. I felt no great surge of joy and exaltation—only a mixture of more subdued feelings. There was a quiet satisfaction that we had finally made it; a tinge of surprise that I, Ed Hillary, should be standing here on top when so many good men had failed. Behind it all my brain constantly churned out its familiar mental arithmetic—how many litres of oxygen did we have left? Could we get down safely?"

—Sir Edmund Hillary, *Memories of Everest*

The large format film, *EVEREST*, is appropriate for all intermediate grades (4-8). This teacher guide will be most useful when accompanying the film but is a valuable resource on its own. Teachers are strongly encouraged to adapt the activities included in this guide to meet the specific needs of the grades they teach and their students. All activites developed for this guide meet National Standards for Science, Geography, Math and English, but are not referenced in this guide due to space constraints and differences in standard use throughout the nation.

Major funding for *EVEREST* provided by

Any opinions, findings and conclusions or recommendations expressed in this material are those of the producers and do not necessarily reflect the views of the National Science Foundation.

MACGILLIVRAY FREEMAN'S

EVEREST

An Educational Resource for Teachers Grades 4 to 8

Introduction

Mount Everest— Where the Earth Meets the Sky

Mount Everest, the pinnacle of the Himalaya, is a name that conjures up many visions: savage rock and blue ice peaks, loneliness and desolation, beauty and grandeur, adventure and fear. It is the stuff of dreams for many. The Sherpa people revere its spirituality; physicians want to study its effects on the human body and mind; geologists want to measure its height and tectonic movement; meteorologists want to record its unpredictable weather patterns; and mountaineers want to climb it simply to get to the top. Why does Everest entice so many? To understand this draw to the ultimate of ventures, we must first look at the region of Mount Everest, its physical characteristics, its people, culture, and spirit, and the uniqueness of the expedition team that allowed them to realize their dream.

A Historic Backdrop

The word Himalaya (always singular) comes from the Sanskrit "hima" and "alaya" meaning seat of snow. Between 1849 and 1855, the Himalayan peaks in Nepal were first surveyed in the *Great Survey of India*. At the time, it was not known that the tallest mountain in the world was part of this mountain range. Lying tucked away in the northeast corner of Nepal, bordering Tibet, Mount Everest, known as Roman Numeral XV then, was hidden by other impressive peaks and not prominently visible.

Calculating the height of such a mountain was indeed a challenge, and it was not until much later that altitudes were computed with any degree of accuracy. But in 1855, peak XV was estimated to be 29,002 feet (8,840 m) above sea level. The highest mountain in the world had been found. Now it needed a name. Many were suggested but the Surveyor General of India decided to name the peak after his predecessor, Sir George Everest, a contributor to the *Geodetic Survey of India*. The name was accepted by the Royal Geographical Society of Britain in 1856, and the appellation *mount* was chosen since Everest was a single definitive peak, rather than a massif.

The IMAX® Film Expedition Team

On March 15,1996, a team of climbers, scientists, and filmmakers set off on a mission to reach the summit of the tallest mountain in the world. After years of research and preparation, the team was ready. By late May, the team members had successfully installed research equipment and had brought back the largest format motion pictures ever shot from the top of Mount Everest.

Who were these extraordinary people? Deputy leader Ed Viesturs, a climbing guide and a veterinarian, has summited six of the world's highest peaks without oxygen and has previously climbed Mount Everest three times. Climbing leader Jamling Norgay, son of Tenzing Norgay who climbed to the summit with Edmund Hillary in 1953, is an experienced climber and expedition organizer. He dreamed of going where his father had gone before him.

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Araceli Segarra, a physiotherapist, became the first Spanish woman to reach the top. Japanese climber Sumiyo Tsuzuki has climbed to 22,000 feet (6,706 m) and 23,000 feet (7,010 m) on the north side of Everest on two previous expeditions. Dr. Roger Bilham, renowned geophysicist, joined the expedition hoping to measure the mountain's geologic forces.

Did You Know?

The "wind chill factor" refers to how cold you feel when standing in direct wind versus the actual temperature. When it is cold your body works to maintain heat by allowing heat to escape from your body and warm the air surrounding you. If the air is calm, the heat stays next to your body, maintaining your body temperature. When heavy winds blow, the air around you is constantly moving, taking with it the warm air surrounding you. Your body continues to create heat to compensate. The faster the wind, the more heat escapes and the colder you feel.

For a classroom activity, you can determine approximate wind chill factor with the following formula or use the "Wind Chill Factor Index" (see resources):

Air Temperature minus (1.5 x Windspeed) = Wind Chill Factor

(°F) - (mph) = (°F)

Co-Director David Breashears ascended Everest twice and has won three Emmy awards for his cinematography there. Now, with his Austrian assistant cameraman, Robert Schauer, he faced the challenge of filming the biggest mountain in the world with the biggest camera in the world—an IMAX® camera.

At 10:55 a.m. on May 23, Viesturs and Breashears radioed in that they "couldn't go any further." They had made it to the top. By 11:35 a.m. Norgay, Segarra, and Schauer plus five camera team sherpas (guides) had also reached the summit.

Giant Mountain, Giant Camera

An IMAX camera weighs 92 pounds (42 kg.); a 500-foot (152 m) roll of film weighing 5.5 pounds (2.5 kg.) lasts only 90 seconds—six feet (1.8 m) of film per second. Each 500-foot (152 m) load shoots 1.5 minutes of film, passing through the gate at a rate of 336 feet (102 m) per minute, four times the speed of 35mm. (IMAX differs from other film formats in its wider, horizontal design. It is actually shot on 65mm film and projected on 70mm).

How did the team get this tremendously heavy load up to such heights, and once they did, how did they manipulate the equipment in high winds, thin air, and on icy precipices? They did it in the face of great obstacles and with an amazing amount of inner-fortitude.

First of all, the camera itself had to be specially designed for such conditions. Specifically, it had to be lighter weight. The body was reconstructed out of magnesium, so that now the camera, with batteries and a loaded 500-foot (152 m) magazine of film, was down to 48 pounds (22 kg.) Plastic bearings were used in some critical areas, and synthetic drive belts were added for their flexibility at low temperatures. The camera could now operate at temperatures as low as minus 40 degrees F.

A camera used by news media, in contrast, weighed 26 pounds (11.8 kg) and at the time had enough video tape to record 20 to 30 minutes of information. The camera used to film major motion pictures weighed approximately 50 pounds (22.7 kg) when fully loaded with lenses and film.

A special 32-volt lithium cell battery pack, weighing 6 pounds (2.7 kg.), provided the power and operated well in cold temperatures. In addition, the film base was Kodak Estar. Estar doesn't shrink or rip and is more stable at lower temperatures than traditional acetate.

The Art of Filming

Filmmaker David Breashears says that his biggest challenge was not carrying the IMAX camera, nor braving the cold and the altitude. It was "finding good light in a place where the spring sun quickly gets up high in the sky, making for very flat, unattractive shots." He worried about finding good shots where it was safe to stop and not hamper the progress of the team.

In addition, Breashears had to learn to shoot in the huge IMAX medium, quite different from other filming experiences. He also had to deal with "the contrast problems of filming in extremely bright light reflecting off white peaks." And each shot required a tripod or monopod, without which the shots would be too jittery.

As if those challenges weren't daunting enough, there was always the little problem of loading and unloading film stock with your bare fingers in minus 40° plus wind chill factor!

Tragedy and Triumph

The *EVEREST* Film Expedition Team was not alone on the mountain. On May 10, more than twenty-

three people from four other expeditions summited Everest. Within hours the *Everest* team members learned all was not well with those climbers. That evening a fierce storm blew in. As darkness descended, about twenty climbers were still strung out along the Southeast Ridge, with only a few of them making it to the South Col High Camp (Camp IV) that night.

Team Rescue

Suddenly all ten expeditions on Everest merged into one and everyone scurried about assessing their oxygen and medical supplies with which to aid the rescue effort. A mini-hospital was set up at Camp II, staffed by a doctor on one of the expeditions.

In the end, a total of eight were dead: five climbers died on Everest's south side, and three on the north. One miracle occurred when Dr. Beck Weathers who had been presumed dead, stumbled into camp, severely frostbitten. Both he and another climber, Makalu Gau, were helicoptered to Kathmandu in an amazing rescue operation.

The Film Expedition Team rested and recuperated at Base Camp while monitoring the weather forecasts dispatched from points around the globe. Would they continue their mission now in the face of such tragedy? Breashears summed up the team's feelings: "The mountain is a place of awesome beauty. Despite all the work, the tragedies and the setbacks, we wouldn't be going up again if there wasn't also a lot of joy in it…"

ACTIVITY 1

Prayer Flags

Objective: Students will make Tibetan prayer flags that can be strung together inside the classroom or outdoors.

In the Film: For Climbing Leader Jamling Tenzing Norgay and the team sherpas, offerings to the deities were a natural and serious beginning to the expedition. On the way to Base Camp, Norgay and Tsuzuki stopped to visit Kathmandu's *stupa* of Swayambhunath (a shrine sacred both to Hindus and Buddhists). At Thyangboche Monastery, Norgay offered a ceremonial khata scarf to the presiding monk of the monastery, who in turn, blessed the bundle of prayer flags that Norgay unfurled on the summit. Across the valley at the Buddhist *stupa* of Boudhanath, 20,000 butter lamps, or small oil lamps, were lit and hundreds of devotees joined in the lighting ceremony.

Materials:

- ☐ One sheet of drawing paper 11″ x 17″ (29 x 44 cm) for each student
- ☐ Crayons, markers, or water colors
- ☐ Fishing line or cotton rope
- ☐ Stapler or clothespins

Teacher Prep Notes: Prayer flags are handled in a special way. They should not be put on the floor. If they need to be discarded, the respectful way to do this is by burning them in a clean area. They are never thrown away in the trash. If you choose to do this activity, please try to respect the Tibetan culture.

Messages can be written by individuals, or the class as a whole can decide on two or three messages. Each student can personalize the illustration of the group message. Students can ask their parents for a message and send one from their families.

Artist's drop cloth or muslin material may be used instead of paper. Cut in 12" (30 cm) squares, fold edges, and tape with masking tape to prevent fraying. Use watered-down acrylic paints for messages and symbols.

Did You Know?
More Nepalese have climbed Mount Everest than any other nationality. As of May 2019, Nepalese Sherpa Kami Rita has scaled Everest 23 times, holding the record.

Background:

The Sherpas—Highlanders of the Himalaya

Sherpas, or *people from the east*, are a comparatively small ethnic group that originated in Tibet. Now, about 3,000 of Nepal's more than 10,000 Sherpas live in the Khumbu, an area extending southward from Mount Everest. They raise yaks for milk, hides, and as pack animals. They are also traders, and yak trains still carry buffalo hides and sundry items across the 19,000 foot (5,791 m) Nangpa La Pass to Tibet, returning with salt and wool.

Sherpas make prayer flags that are displayed at the various shrines and monastaries as they make the trek up Mount Everest. They do this to honor the mountain and the spirits living there.

At least forty sherpas or guides, assisted this filming expedition. They carried supplies and camera equipment sometimes weighing over 60 pounds (27 kg.) The film crew was amazed at how fast they could carry these heavy loads up steep slopes at such high altitudes.

To Do:

1. Have students think about messages they would like taken around the world. What would they like to say to students in another part of the world? What would they like to say to world leaders? Examples of messages could include peace to all people, the end of world hunger, or sustainable environmental practices across the globe.
2. With these types of writing prompts, students construct a message which fills the drawing paper leaving a 3-inch (7.6 cm) border at the top. These messages can also be illustrated with symbols of their meaning.
3. When finished, the teacher may turn the border over the fishing line or rope and staple or clothespin the flags on. These can be hung in the classroom or outdoors.

What's Going On and Why: Prayer flags are rectangular pieces of cloth, 12″ x 12″ (30 cm x 30 cm), that have Buddhist scriptures, mantras, and deity symbols written on them. They are hung throughout the Himalayan region in many places including monasteries, houses, and atop poles on Mount Everest. It is believed that the prayers written on the flags rise toward the heavens with each gust of wind. These offerings to the gods are believed to carry the written messages to all parts of the world.

Butterfly Adaptation

Objective: Students will construct a mobile to illustrate the differences in the adaptations between butterflies found in high altitudes and those found in regions where students live.

In the Film: As the expedition team treks through many ecological zones to their first base camp, they notice animals, insects, butterflies, and plants. Each species displays its unique adaptations to the Himalayan environment. Co-Director David Breashears even spotted an Impeyan pheasant, Nepal's iridescent national bird, as well as an endangered musk deer on this expedition.

Materials:
- ☐ Drawing paper for each student
- ☐ Crayons, markers, or water colors
- ☐ Scissors
- ☐ 1 wire hanger for each student
- ☐ Fishing line or thread of various lengths for each student
- ☐ Tape
- ☐ Access to a library and Field Guide books about butterflies

Teacher Prep Notes: This activity can take several days for research, oral reports and the actual mobile construction.

Background: Butterflies have co-evolved with plants. In areas where there is a diversity of plants, scientists will often find a diversity of butterflies. Few species of butterflies can exist at high altitudes. They have been able to adapt to the oxygen restrictions of these areas by decreasing in size. Their darker color allows them to absorb solar warmth more efficiently. The climate in the high altitude areas affects their activity and butterflies slow down or stop activity completely when there is cloud cover. They are dependent upon the sun's energy. The caterpillars of these butterfly species are also ecologically flexible. They may become inactive at a moment's notice. The caterpillars have adapted to high altitude environments by having flexible life cycles. Their life cycles can be completed in one and one-half years, if there is an early spring as opposed to two years following long winters.

To Do:
1. Assist students as they research the types of butterflies found in the regions where they live.
2. Ask students to research the types of butterflies found in high altitude regions of the globe. Students can report on the similarities and differences between butterflies that live in their region and those which live in high altitudes.
3. After students have reported, have each one select 3 species of butterflies from their research. Try to get a good representation of geographical regions from the class so the model students construct will show diverse butterfly adaptations.
4. Have students draw their butterfly selections, color them in and carefully cut them out.
5. To make the butterfly mobile, have students attach each butterfly they have made to a separate piece of fishing line or thread with tape (tape may not adhere if crayons are used. In that case, make a small hole to tie thread or fishing line). Tie each piece of line or thread to the hanger in different areas, and at different heights, so the butterflies hang without touching each other. Hang each mobile from the ceiling.

What's Going On and Why: The butterfly mobiles represent the various populations of species that are able to live in a variety of geographical regions, including high altitudes. By observing the paper butterflies, students can see the diversity of life in the regions of the world and relate this diversity to their own region.

Taking it Further: Discuss the different sizes and colors of the selected butterflies. How do these affect their survival?

Research the types of plants that live in each of the regions where the mobile butterflies live. Discuss the diversity and interdependence of the plants in relation to the butterflies.

ACTIVITY 3

Plate Tectonics: Building Mountains

Objective: Students will design two continental plate models with horizontal land features and observe the results created by the force of plate tectonics.

In the Film: The *EVEREST* team takes a helicopter trip from the Kathmandu Valley to the village of Lukla to begin their journey up the mountain. During the flight, Dr. Roger Bilham is coaxed into giving an impromptu geology lesson on the incredible natural forces that are at work to create the peaks of the Himalaya. Computer-Generated Imaging (CGI) assists in demonstrating the millions of years of growth of the Himalaya. The Indian plate, in its collision with the Asian plate, proceeds to slide beneath the Asian plate. The top of the Indian plate is scraped off and begins stacking up, creating the mountain range. The continual force of this collision pushes the land masses upward to form the peak of Mount Everest and the Himalaya.

Materials:
- ☐ Several colors of plastic modeling clay
- ☐ 2 rectangular pieces of cardboard or Styrofoam cut to 8½″ by 11″ (22 x 28 cm)
- ☐ Plastic wrap
- ☐ Tape

Teacher Prep Notes: This activity is designed to be done as a demonstration, but can be adapted for small group experimentation.

Background: Today we know that the ten tallest mountains in the world are found in the Himalaya. It is in this area where 20,000 foot (6,096 m) peaks are common along the 1,500 mile (2,414 km) long range. Mount Everest is calculated to be 29,032 feet (8,848 m) as of December 2020 and growing, up to 1.6 inches (4 cm) a year. The growth of this mountain and the surrounding range can be attributed to continental drift and plate tectonics. Scientists believe that the continents of the earth are constantly moving, or drifting, on the layer of semi-molten rock found below the crust of the earth. This theory is coupled with the idea that these constantly moving continents collide into each other along their perimeters. The areas where the continents collide are areas where heavy seismic activity (earthquakes, volcanoes) is found. It is also at the perimeter of the continents that very high mountain ranges, such as the Himalaya, are found and are illustrations of the force used to push mountains to great heights.

To Do:

1. Begin by attaching a piece of plastic wrap, approximately 2″ (3 cm) wider and longer than the piece of cardboard or Styrofoam with tape.

How Big is Mount Everest?

STRUCTURE	LOCATION	COUNTRY	HEIGHT	
Mt. Everest	Himalaya	Tibet/Nepal	29,032 ft	(8,848 m)
Mt. McKinley (Denali)	Alaska	United States	20,320 ft	(6,198 m)
Elbrus	Caucasus Mountains	Russia	18,510 ft	(5,646 m)
Mont Blanc	Alps	France/Italy	15,771 ft	(4,810 m)
Matterhorn	Alps	Italy/Switzerland	14,690 ft	(4,480 m)
Mt. Whitney	California	United States	14,505 ft	(4,421 m)
Mauna Loa Volcano	Hawaii	United States	13,680 ft	(4,172 m)
Cameroon Volcano	Cameroon	Africa	13,435 ft	(4,095 m)
Asama Volcano	Nagano-ken	Japan	8,425 ft	(2,568 m)
Burj Khalifa	Dubai	United Arab Emirates	2,722 feet	828(m)
Empire State Building	New York	United States	1,472 ft	(449 m)
Eiffel Tower	Paris	France	984 ft	(300 m)
Gateway Arch	St. Louis	United States	630 ft	(192 m)
Great Pyramid	Giza	Egypt	450 ft	(137 m)

2. Set the boards on a flat surface, such as a table top, making sure the plastic wrap lays flat around the board.
3. Use the clay to create a “continent” on each of the boards, allowing for some of the land form created to come off the board onto the plastic wrap. The land form created could be modeled after Mt. Everest and the Himalaya Mountains.
4. Once the two continents are complete, arrange them on a flat surface *as indicated in Diagram A and B.*
5. Now firmly push the two land forms, still attached to the boards, together until they touch. Ask students to observe what happens to the portions of the land forms as they begin to make contact. Keep pressing firmly on the boards, forcing them to move together. Notice that the harder you push, the closer the land forms get and the more clay is moved away from the collision point. *See Diagram C.*

What’s Going On and Why: In this demonstration the force of plate tectonics is simulated by the pushing of the clay land forms together. The constant propelling represents the forces that are moving the continents of the earth. When two land forms collide, several things can occur and each of these can be related to actual geological occurrences on earth.

One type of reaction is called subduction. This occurs when the two plates collide and one, for a variety of reasons, is forced below the other one. This is evident as the Pacific plate descends beneath the Andean plate, along the Andean Trench, off the coast of South America.

Another type of reaction causes huge mountains to form. The area where two plates come together is called a convergent boundary. *See Diagram D.* The Himalaya were formed when the Indo-Australian plate collided with the Eurasian plate. The dirt and rock from each plate was forced together and because of the force, crumpled up to make tall mountains.

Collisions between continents can also occur in a different manner. When two continents collide with a sliding motion the reaction is called a transformation fault. A transformation fault can be seen in the San Andreas fault in California. Here the Pacific Plate is moving northwest relative to the North American plate. Earthquakes occur near areas that are transformation faults as the land forms slide by each other.

In this activity the clay “land forms” collide with the force you apply. Depending on how hard the force is, the clay could be forced up to form tall, jagged mountains, similar to Himalayan peaks.

Taking it Further: By varying the amount of pressure, how might the outcome be affected? Discuss why some areas of the clay land forms might receive more pressure than others. How would this affect the seismic activity in the areas? What parts of the land form would students expect to be more seismically active? Try the activity again creating different reactions to the forces of plate tectonics and continental drift.

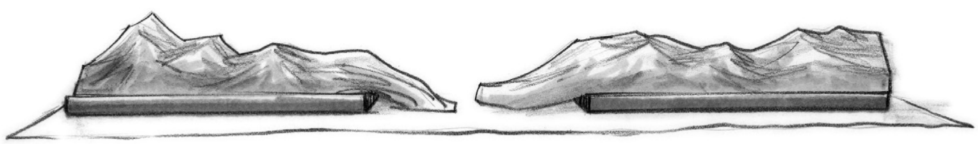


Diagram A

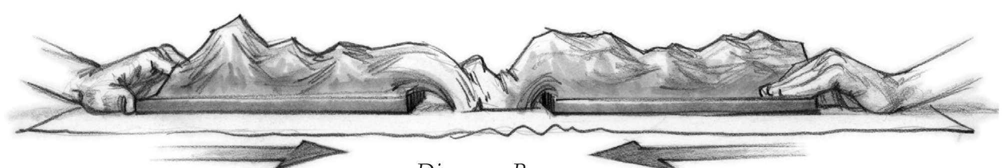


Diagram B

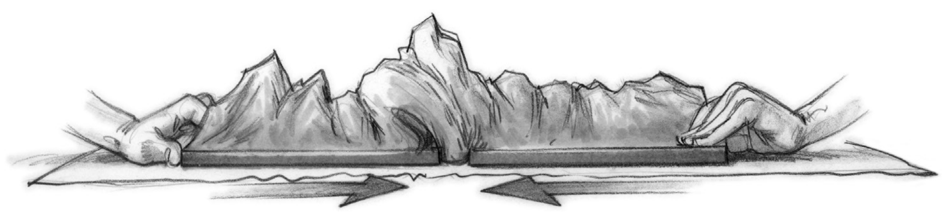


Diagram C

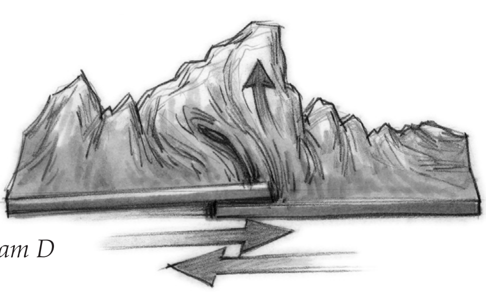


Diagram D

ACTIVITY 4

What Is Your Latitude and Longitude?

Objective: Students will create a map of the classroom and learn how to use latitude and longitude to locate features.

In The Film: *EVEREST* film team members arrived at base camp on Mount Everest fully aware of the land formations and the possible weather patterns that might affect their climb. They each studied maps of the region and were able to gather valuable information about the world's tallest peak by evaluating latitude, longitude and other geographical information. By learning as much as possible from latitude and longitude data, before they arrived, the team was better prepared for the hazards an expedition like this presents.

Materials:

- ☐ Large sheets of blank paper—approximately 11″x17″ (29 x 44 cm)
  One sheet for each student
- ☐ Measuring tape
- ☐ Pencil for each student
- ☐ Ruler for each student
- ☐ A large world map (with latitude and longitude lines)

Teacher Prep Notes: This activity is designed as a precursor to: Global Positioning System (GPS) (page 10). The map created by students here will be used in that activity.

Background: Before beginning this activity, show the class a world map that depicts lines of latitude and longitude. Explain that lines of latitude, also called parallels, circle the earth parallel to the equator, like steps on a ladder. These lines run east and west, but are measured as north or south from one pole to the other. Lines of longitude, known as meridians, run north and south through each pole. Lines of longitude are separated furthest at the equator, and are measured as east or west of the Prime Meridian. The Prime Meridian runs through Greenwich, England.

The lines of latitude and longitude do not change; they are static. These lines are read as the number of degrees, followed by directions of north, south, east or west. Latitude is read first, followed by longitude. An example of proper latitude and longitude coordinate recording would be: 30°N (latitude) and 90°W (longitude). Have students mark these coordinates on the world map. Their location is New Orleans, Louisiana. Discuss why these lines are important. How can they be used for navigation? What would happen if we had no directional lines on maps?

To Do:

1. Create a map of your classroom, using your own latitude and longitude lines to document where objects are in the room.
2. Measure and record the dimensions of the classroom and using these measurements, find the center of the classroom and record this information.
3. Fold the large sheet of paper in half along the width, then open it. Fold it again along the length and open it again.
4. Using a ruler, draw a line on both folds to create an X and Y axis on the paper.
5. Label the X and Y lines while marking 0º at their intersection. *See Diagram A.*
6. Using a ruler, create a graph on the paper by drawing lines along both axis lines every inch (2.5 cm), being sure that the number of lines equals the number of feet of the classroom. Every line on the graph should equal 1-foot (.3 m). The result: each square of the graph will equal one square foot of the classroom.
7. Determine which walls of your classroom face north, south, east and west and label your map accordingly.
8. Label the lines going out from the X and Y axis 10º, 20º, 30º, 40º etc. Continue in all four directions to the end of the paper. *See Diagram B.*
9. Measure the position of furniture in the classroom by square feet or meters and copy the location on the map, using the zero point of the grid as the center of the room. Students can map as many features as they wish depending on how detailed they want classroom maps to be. *See Diagram C.*
10. When the map is complete, challenge students by moving a piece of furniture. What happens to the map when the furniture is moved? Discuss how students could alter the map to reflect the changes in the room, keeping in mind that the lines of latitude and longitude will not change.

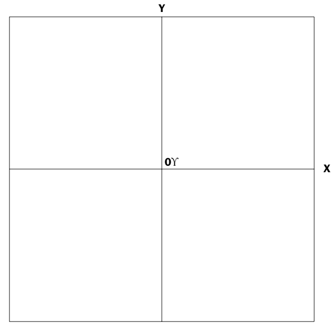


Diagram A

Diagram B

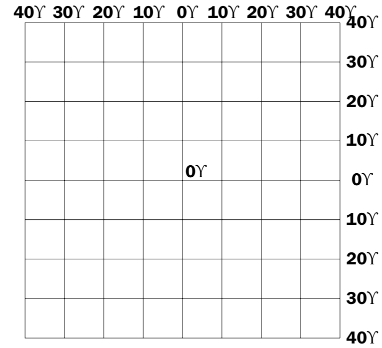


Diagram C

Taking it Further: Ask the students to use the latitude and longitude lines to locate different objects in the room. For example: Where is the teacher's desk? The answers should be read as number of degrees followed by the directions north, south, east or west.

In the same manner, have students create maps of the school campus or of their neighborhoods. Have students locate objects or special locations on those maps and ask other students to find them according to the coordinates given.

ACTIVITY 5

Global Positioning System

Objective: Students will learn how radio waves sent from orbiting satellites can be used by Global Positioning System (GPS) receivers to find latitude and longitude positions.

In The Film: As a part of the *EVEREST* Filming Expedition in 1996, geophysicist, Dr. Roger Bilham joined the team to study the processes responsible for forming and reforming Mount Everest. Dr. Bilham has been instrumental in applying Global Positioning Systems (GPS) satellite receivers to the measurement of changes in distance between horizontal point on the surface of the earth. Members of the film team carry small, portable GPS receivers to metal pins that have been driven into the ground at specified points on Mount Everest. By comparing the readings taken at these points over time, geologists can track the movements of Mount Everest and the Himalaya.

Materials:

- ☐ Maps of classroom made in Activity 4 (page 8)
- ☐ 3 pieces of string per student
- ☐ Ruler
- ☐ Colored markers
- ☐ Tape

NOTE: Each string should be long enough to reach anywhere on the map from a single point along the edge of the map.

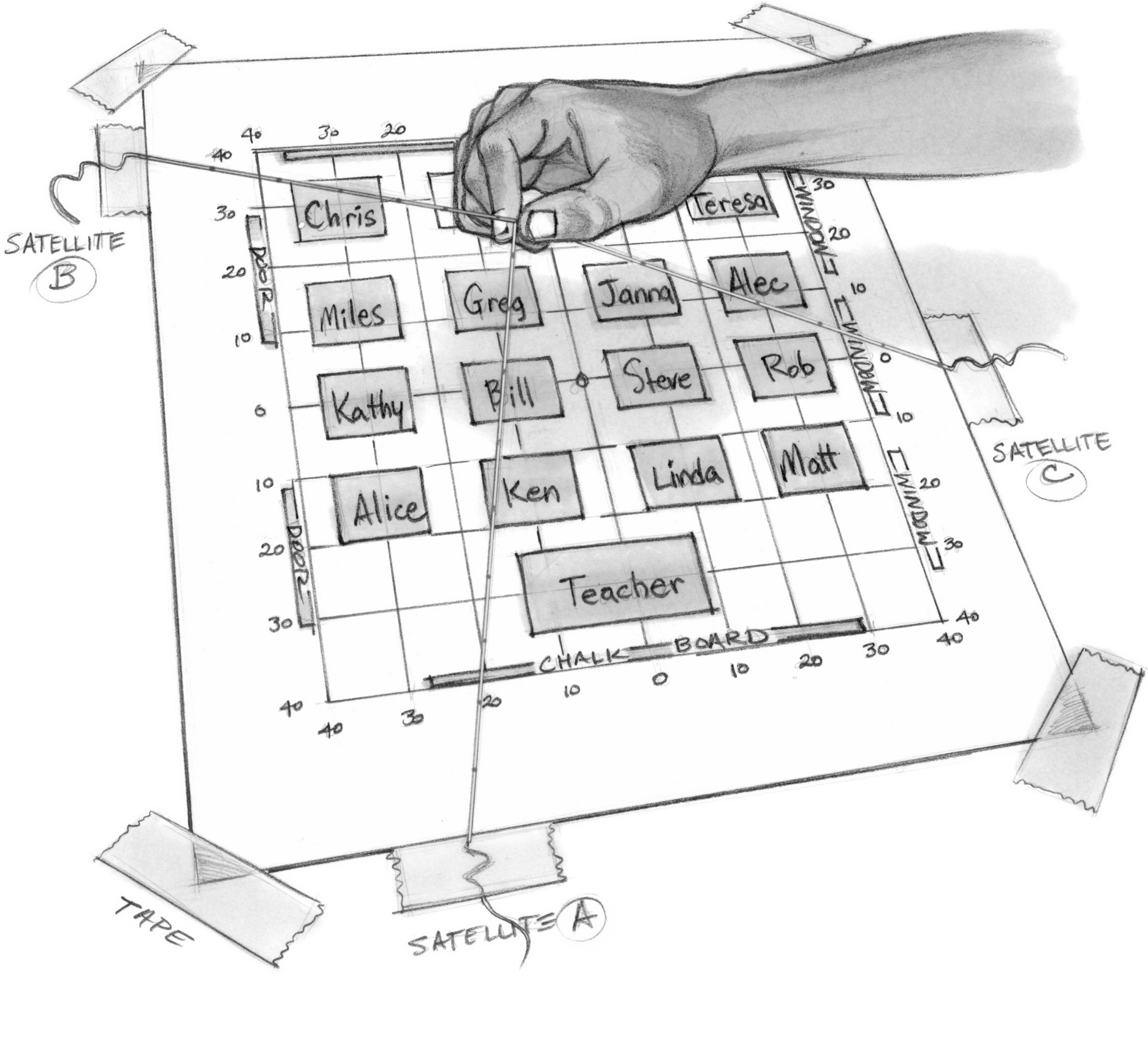
Teacher Prep Notes: Classroom maps made in Activity 4 will be used to perform GPS experiment.

Background: The Global Positioning System (GPS) uses communication between earthbound receivers and approximately 24 satellites that are orbiting the earth at very high altitudes. The satellites, which orbit the earth twice a day, continually broadcast the time and its position (latitude and longitude) via radio wave signals that are picked up by the ground based GPS receivers. The receivers pick up the radio waves and measure the time intervals that are needed to get the satellite's signals. The receiver then calculates the distance between it and the satellite (SPEED X TIME = DISTANCE). The GPS receivers must get signals from three orbiting satellites in order to provide accurate latitude and longitude positions on earth. Four satellite signals must be received in order for the GPS receiver to provide accurate latitude, longitude and altitude positions.

The Global Positioning System was designed for military use and is now readily available in nearly every corner of the globe. GPS receivers and smart phones give people extremely accurate navigation information. The Global Positioning System has the ability to give every square meter of the earth's surface an independent address, which can be used for mapping terrain. As continental plates shift and move, their locations can be recorded and continuously updated. Thanks to the information gained using GPS, scientists can track the latitude, longitude and altitude of mountain ranges such as the Himalaya.

To Do:

1. Ask students to label each of their strings A, B and C. Each string represents a different satellite.
2. Using the colored markers, have them measure each satellite string with 1-inch (2.5 cm) increments. Have all students use the same color for each measurement, i.e. all students will use a blue pen to mark the first increment, a green pen to mark second, etc.
3. Have students tape their classroom maps, made in Activity 4, to the desk or table top to prevent them from moving.
4. Select three locations around the edge of the map and have each student place the designated string there, one in each of the areas you choose. Secure the strings with tape.
5. Radio waves travel 1,860 miles in 1/100th of a second. Each mark on the satellite string represents 1/100th of a second. This means that two inches on the string will equal 2/100ths of a second and so on.
6. Give the following information to students: Satellite A received radio signals in 5/100ths of a second; Satellite B received radio signals in 7/100ths of a second and Satellite C received signals in 9/100ths of a second.
7. Have students count the inches (centimeters) on their strings to correspond with the information given. (Satellite A string at 5 inches, Satellite B string at 7 inches and Satellite C string at 9 inches). Students should hold onto each string at the corresponding mark, until they have all three strings, held together in one hand, over the map.
8. If there was a GPS receiver at the point where all the strings meet, it would know where the orbiting satellites were, how long the signals took to reach the receiver and from that information could tell us the exact latitude and longitude of the map position. If a fourth string were



added to the activity, information about the altitude of the location would be known.

What's Going On and Why? The strings representing the three satellites are needed to display the necessary coordinates to provide accurate GPS readings. One string, or satellite signal, creates an arc corresponding to the amount of time the signal took to arrive at the GPS receiver. The arc, created by the curve of the string, shows the GPS receiver could be anywhere along its curve. When a second string, or satellite, is added, the range of possible locations is narrowed. The third string, again representing a satellite, narrows the possible location for GPS receivers to one point, where the arcs from all three strings or satellites meet.

Taking It Further: Use the GPS or map app on a smart phone to explore longitude and latitude measurements around the world.

Can You Take It?

Objective: Students will exercise to test changes in their pulse rates and to experience the need for more oxygen.

> **Did You Know?**
> Living creatures must breathe in enough oxygen to live. At sea level, air presses on us at about fifteen pounds per square inch and one-fifth of that air is oxygen. As we climb higher than sea level the amount of oxygen available to breathe decreases, and the air thins. In fact, the summit of Mount Everest has only one third of the air pressure found at sea level and therefore has only a third of the oxygen.
>
> High altitudes and a lack of oxygen can cause myriad physical problems. Symptoms of Acute Mountain Sickness (AMS) are headaches, weakness and nausea. These usually improve rapidly, and climbing slowly—no more than 1,500 (457 m) per day over 10,000 feet (3,048 m) and acclimatizing yourself to the altitude gradually can help considerably in avoiding these symptoms. Severe cases of oxygen depletion can result in High Altitude Cerebral Edema (HACE) which requires immediate treatment or may be fatal. More common is High Altitude Pulmonary Edema (HAPE), water in the lungs, which can be dangerous without treatment as well. Breathing oxygen will help, but rapid descent will be necessary.

In the Film: In the film we see people silhouetted by the huge, rocky peaks of the Himalaya in the background. These mountain climbers are working their way up the dangerous face of Mount Everest, pushing their bodies and minds to the limit. Every foot of their ascent causes their hearts to beat faster, partly from extreme physical exertion, partly from the thinning air, and partly from sheer exhilaration. Deputy Climbing Leader, Ed Viesturs is the only team member to climb Everest without bottled oxygen because he has conditioned his body, by a process called acclimatization, to the the lack of oxygen.

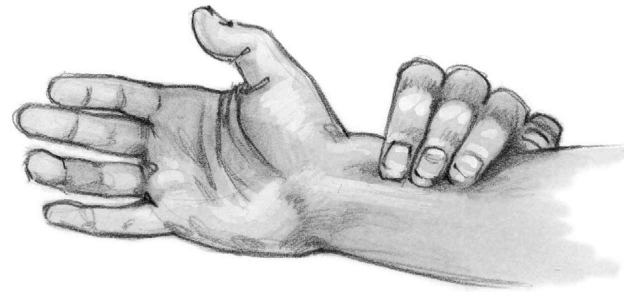
Materials:
- ☐ Four students as test subjects
- ☐ A clock with a second hand
- ☐ Access to a staircase (with at least ten steps)
- ☐ Clothes-pin for each test subject
- ☐ Chart paper
- ☐ Pencil
- ☐ A table
- ☐ A comfortable chair

Teacher Prep Notes: If no staircase is available, student may run in place or do pushups. Students may choose to pinch nose with fingers rather than use the clothes-pin.

Background: One way to take a pulse measurement is to lightly hold the right arm of another person. Gently grasp the arm by the wrist with your fingers. Place the tip of your middle finger over the artery located near the tendons on the inside of the wrist. You will feel a stronger pulse if you place your middle finger on the artery nearer the thumb, moving your hand until you feel a gentle throbbing. To record the pulse rate, use a clock's second hand and count the number of beats you feel for ten seconds.

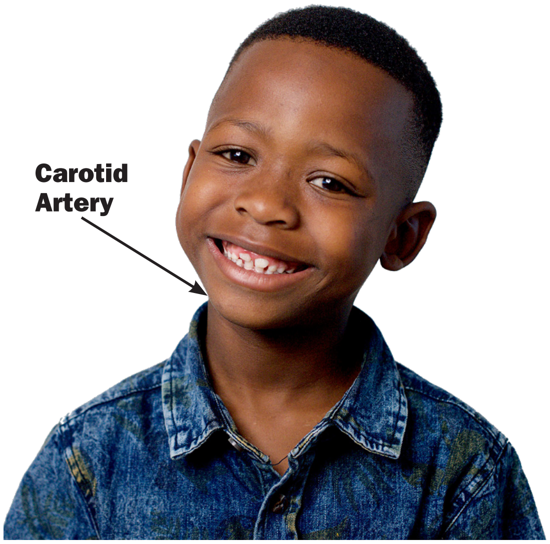
Use the carotid artery as another way to measure pulse rates. The carotid artery is located on the inside of your neck, just below the jaw.

NOTE: It is important not to take a pulse reading with your thumb. The thumb has large blood vessels and a pulse which can confuse your measurement.



To Do:

1. Set up the table and chair as a "pulse-taking test station." The location for the test station should be in a relaxing atmosphere, free from loud noises, with low lighting. The test station area should also be near the stairway. In the test area each of the four student test subjects will have their pulse rates measured and recorded. The measurements should be taken when the subject is calm, and has a resting heartbeat.
2. Have students practice taking pulses several times until they feel comfortable with the procedure. Students may be able to take the pulse measurement from the carotid artery more easily than from the wrist but they should learn how to administer both forms of pulse reading.
3. Take a resting pulse rate by using one of the two methods listed above.
4. One at a time, have each of the student test subjects walk briskly up and down the stairs one time, returning to the test station for pulse reading. Record the pulse rates of each test subject on the chart paper under the heading "Brisk Stair Climb—X1."
5. Next, have the same students who participated in the first test, run up and down the stairs, one at a time, as fast as they can. Make a new heading on the chart "Fast Run Stair Climb" and record the new pulse rates, again for ten seconds.
6. Now, increase the number of "running" trips to three. A new section will be needed on the chart for the pulse data and it will be titled "Stair Run — X3."
7. For the last part of the test, the students will deal with a different variable. Each student will close their nose with a clothes-pin before they run the stairs. Students should plan to keep the clothes-pins on their nose until after their pulse rates have been recorded. A new heading will be needed for this test, "Pin On Nose — Run X3." Record the pulse rates for each student performing this test in this section of the chart.

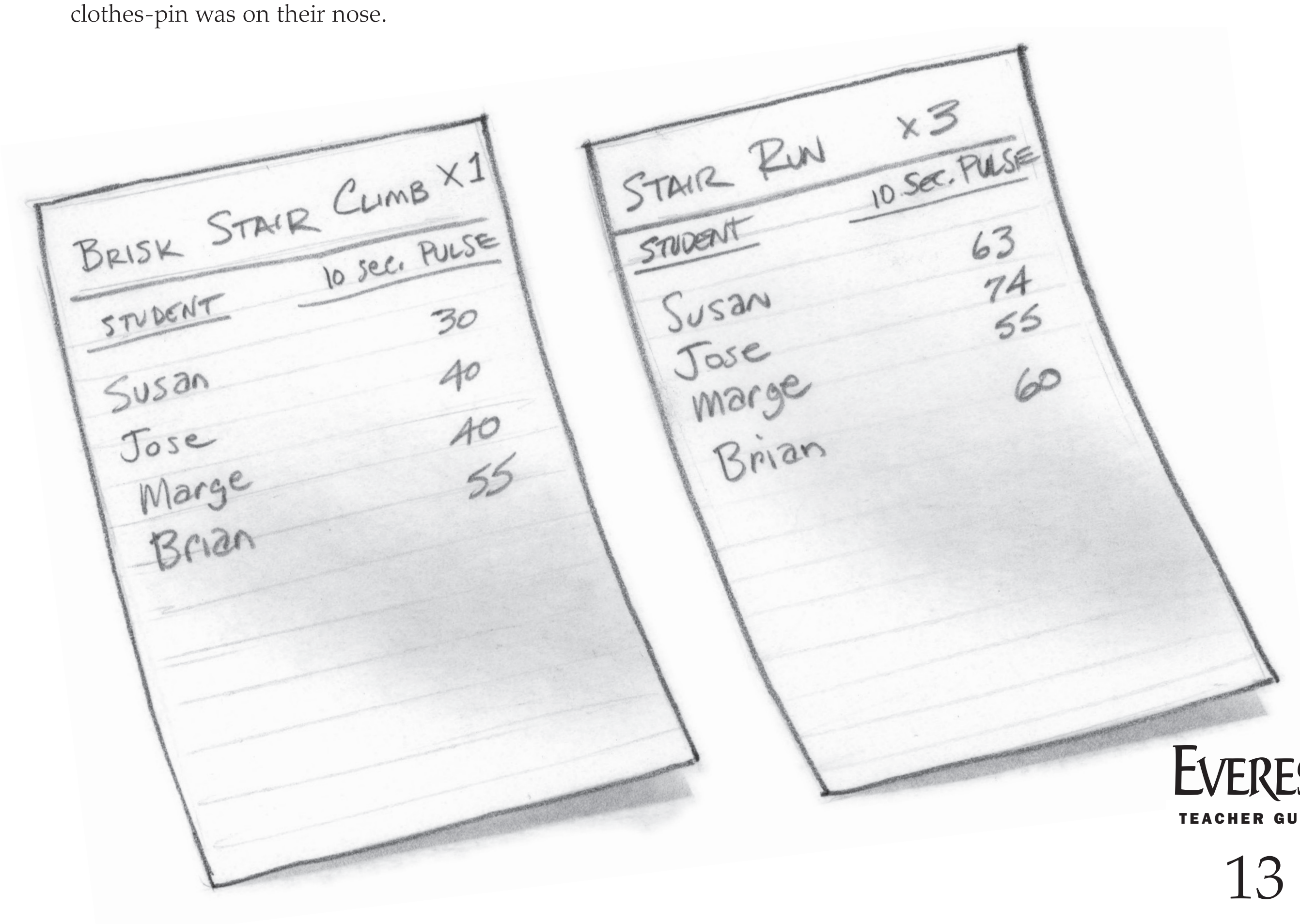


NOTE: If any of the student test subjects becomes lightheaded or dizzy at any time during the activity, stop the tests and select another test subject.

8 Ask the test subjects to describe how they felt both mentally and physically as they completed each portion of the activity. Ask them if they noticed a change in their breathing rate as they increased the workout length, duration, and difficulty. Ask how each felt when the clothes-pin was on their nose.

What's Going On and Why: Your body is an incredible machine that has interdependent systems for optimum performance. The circulatory system is very dependent on the respiratory system. When one system is working hard the other systems are taxed to work harder. When you exercise, your heart is forced to work harder to pump blood to supply oxygen to your muscles. As exertion increases, more oxygen is needed by the muscles. The lungs expand more fully and more often when the heart is beating faster. This is why you breathe more heavily when you perform rigorous exercises. Oxygen is brought into the body by the lungs, then transferred into the blood and muscles. Men and women who climb tall peaks, such as Mount Everest, push their bodies to extremes. They must acclimatize themselves to the high altitude and the subsequent lack of oxygen. The climbers featured in the film were able to acclimatize their bodies to the high altitude environments by spending extended periods of time at base camp and at high elevation training areas.

Taking it Further: Have students graph the results of the test and display. Are students who exercise better able to cope with the lack of oxygen? Have test subjects make three more trips up the stairs, this time carrying a heavy load of books. How does this experience relate to what the climbers on Mount Everest endure?



Drink It Up!

Objective: Students will experiment with pieces of fruit to see the effects of dehydration.

In the Film: Luck plays a heavy role in the outcome of situations on a mountain such as Mount Everest, but experienced climbers know how to take advantage of every opportunity to make their own luck. They prepare well in advance by planning all the equipment, food and other supplies they'll need. And they plan for emergencies: oxygen bottles for the high altitudes, special clothing for the extreme temperatures, and specialized foods and beverages to keep up their energy levels and avoid illness.

Materials:
- ☐ A fresh, firm banana
- ☐ A sharp knife
- ☐ A few drops of lemon juice
- ☐ A cookie sheet
- ☐ Tongs
- ☐ Oven mitts
- ☐ An oven

Teacher Prep Notes: This activity is designed to be done as a demonstration and may take several class periods to complete. Teachers may choose to have students make observations about the dehydration process as a part of the activity.

If an oven is not available, banana slices may be dried naturally by leaving out in a sunny location for several days. The sunlight and the air will eventually dehydrate the slices, but an oven will speed up the process. Natural dehydration is historically how people have preserved fruit and vegetables for out-of-season use. If you choose to dehydrate this way, do not allow students to eat the dehydrated banana slices. Exposure to bacteria and other airborne organisms will be increased due to the length of time the slices are exposed. A fruit and vegetable dehydrator may be substituted in place of the oven. Follow the manufacturer's directions for the operation of the food dehydration machine. Packages of pre-dried bananas can be purchased if no means to dehydrate the fruit as indicated are available.

Background: Men and women who attempt high altitude climbing face one of the most serious problems for humans: dehydration, the abnormal depletion of body fluids. At high elevations, the human body must work harder than at lower elevations to complete even the simplest tasks. Also, in conjunction with the cold temperatures, this cold, dry, high altitude air robs the human body of much needed water.

Each time we exhale, we expel gases mixed with water vapor into the air. In dry regions we are forced to breathe more. As we breathe more oxygen, water is released into the atmosphere in vapor form.

Evaporation also uses up moisture. Body water, now in perspiration form, comes to the surface through the pores of the skin where it is exposed to the cool dry air. The increased amount of water vapor released into the air and the evaporation of sweat from exercise are two reasons why keeping the body hydrated is a major concern.

To Do:
1. Peel the banana and slice it into pieces about 1/2 inch (2 cm) thick.
2. Dip each banana slice into the lemon juice to keep it from turning brown during the activity.
3. Place the banana slices onto the cookie sheet, forming a single layer. Make sure that the slices are not touching each other or the side of the pan.
4. Place the cookie sheet into the oven that has been pre-heated to 140° Fahrenheit (60° Celsius). Allow the banana slices to dry in the oven for several hours. Turn each banana slice over, with the tongs, every half hour to allow even drying on both sides. It is important to dry the banana slices, not cook them.
5. As the slices begin to dehydrate, their shape and texture will change. The thickness and mass will also change as the fruit is dehydrating.
6. The banana slices will be fully dehydrated when they no longer stick to the pan or to the other slices. Another way to tell if the slices are fully dehydrated is by cutting open one slice and squeezing it. If no moisture can be expressed then the slice is dehydrated. Allow the slices, now called chips, to cool completely.
7. Once the chips are cool, allow students to taste the dehydrated food. Ask students to compare the banana slices to the banana chips. Ask students to explain the importance of fluid to the taste and usefulness of the banana. Compare what happened to the banana slices to what might happen to a person, if not enough fluid is available.

What's Going On and Why: Almost 75 percent of the human body is made up of water. Since our bodies contain so much moisture, we are always in danger of becoming dehydrated. Dehydration is a process that removes bound water (oxygen and hydrogen molecules) from the body or from moist food. The banana slices used in the activity illustrate the importance of water in living things and show us what happens when the water is removed from something that was once alive.

Dehydration is one of the most dangerous aspects of a trek to Mount Everest's summit. The moisture found in the exposed portions of your body, such as your lips and eyes are robbed of their moisture when the air is dry. When too much water is taken from the body either from evaporation of sweat or from breathing, and is not replenished, the danger of dehydration is high. The human body, with its exposed supple skin, is constantly losing moisture in much the same way as the banana slices in the activity. Have you ever felt your lips or eyes begin to get dry because of low humidity? It is vital for one who exercises regularly or travels to dry areas to keep replenishing the body with liquid as dehydration occurs. Signs of dehydration include fatigue, headaches, and even muscle cramps. If not corrected, dehydration can be fatal.

ACTIVITY 8 Talk It Out!

Objective: Students will participate in discussions about ethics and personal beliefs, relating them to the *Everest* Expedition.

In the Film: Members of the *Everest* expedition are forced to make difficult choices in their attempt to summit the peak of Mount Everest. They must choose between the progress of their own expedition and the lives of other climbers on other expeditions who are also on the mountain. In the film, members of several other teams are in trouble. The lives of these climbers depend on assistance from other teams.

The *Everest* Film team members made some hard choices. They helped the rescue efforts of these other teams in trouble by giving up their precious oxygen bottles. They prepared camps below to help the wounded who made it down, and they talked by radio to the team leader of one expedition encouraging him to keep his spirits up.

Materials:
- ☐ A large room
- ☐ Seats arranged so students can see each other

Teacher Prep Notes: You may choose to duplicate the excerpts, one per student, to allow for silent reading. To adapt to a creative writing activity, develop journals for students to record feelings about the excerpts.

Background: Years ago, few people were able to brave the elements of Mount Everest. Those climbers trained for months, preparing their bodies and minds for the experience. Today, unfortunately, Mount Everest offers a challenge for those who may not have the required experience to climb a mountain of Everest's magnitude. People who have not trained themselves well for the climb may require rescue if they become stranded. The ever-changing weather surrounding the peak of Mount Everest can also create dangerous situations for all climbers.

To Do:
Read each of the excerpts below to the students. After each reading, lead a discussion using the questions following each excerpt. The discussion should be a catalyst to get students talking about issues that are crucial to teamwork, problem-solving and to survival in stressful situations. Encourage students to be frank with the answers they give and accept all possible answers.

NOTE: Excerpts were taken from a book by Jon Krakauer, called *Into Thin Air: A Personal Account of the Mount Everest Disaster*. ©1997, Jon Krakauer. Available in paperback from Anchor/ Doubleday.

What's Going On and Why: Mountain climbers not only have to overcome the physical challenges of the climb itself, but must deal with their inter-personal feelings as well. The feelings that a mountain climber has can affect the outcome of the expedition as much as physical issues. Fear can cause a climber, who is already thinking more slowly due to lack of oxygen, to make irrational decisions. Any decision made by one member of a team will affect the other team members. For example, if one person needs to return to base camp, the entire team will be affected. One person may lose a "safety buddy" while another person may need to carry more gear up the mountain to accommodate the loss of a team member.

Feelings of isolation, often felt if a climber is detained in a tent during storms, can affect the health of the climber. Dealing with the environ-mental impact on the body can also force a climber to deal with interpersonal feelings. Feelings of inadequacy or disappointment may plague a climber who is unable to reach the summit due to severe weather conditions, snow blindness, or frostbite.

Excerpt One:

"Straddling the top of the world, one foot in China and the other in Nepal, I cleared the ice from my oxygen mask, hunched a shoulder against the wind and stared absently down at the vastness of Tibet, a boundless expanse of dun-colored earth. I'd been fantasizing about this moment for months. But now that I was finally here, actually standing on the summit of Mount Everest, I couldn't summon the energy to care.

It was early in the afternoon of May 10, 1996. I hadn't slept decently in 57 hours. The only food I'd been able to force down over the preceding three days was a bowl of soup and a handful of M&M's. Weeks of violent coughing had left me with two separated ribs that made breathing an excruciating trial. Twenty-nine thousand, twenty-eight feet up in the troposphere, there was so little oxygen reaching my brain that my mental capacity was that of a slow child.

I'd arrived on the summit. I snapped a few quick photos and turned and headed down from the peak. My watch read 1:17 p.m. I had spent less than five minutes on the roof of the world."

—Jon Krakauer

Discussion Questions:

If you were a climber, how would you feel when you reached the peak of Mount Everest?

How could the feeling of being "let down" at reaching the summit affect your descent?

How would extreme cold or lack of oxygen affect you or your climb? How could you overcome these elements to make it to the summit?

At what point would you abandon your dream to reach the summit? Would you stop after your ribs were injured, like those of Mr. Krakauer?

Would you continue to the summit even if you were not able to eat the balanced meals you knew your body needed? Why or why not?

Would you risk your life to reach the summit of Mount Everest? Why or why not?

Excerpt Two:

"As I continued my descent, I checked my oxygen-tank gauge and found that my tank was almost empty. I needed to get down fast. In the perilously thin air, my brain could not function long without the supplemental gas.

Fifteen minutes of cautious shuffling along a 7,000-foot abyss brought me to the notorious Hillary Step, 30 feet of near-vertical rock and ice. One rope had been fixed in place to navigate it, and as I clipped onto it and prepared to rappel over the lip, I was greeted with an alarming sight. Down below me, three climbers were hauling themselves up the rope that I wanted to descend, and more than a dozen people were lined up behind them. This meant that I had no choice but to unclip myself from the communal line and step aside."

—Jon Krakauer

Discussion Questions:

What thoughts would go through your mind if you noticed a low oxygen level while climbing down from the summit of Mount Everest?

How would you feel as you "shuffled" along the dangerous cliff, knowing that you were running out of oxygen?

How would you feel knowing that other climbers had died on this stretch of trail?

What would you think when you saw the other climbers attached to the rope you wanted to use?

What would you say to these people, keeping in mind that you may not know them, and that they are trying to achieve the same goal as you?

How would you feel if you saw a lone climber descending from the summit, knowing that there is only one way for each of you to maneuver over the face of the cliff?

Describe the feelings you would have as you unclipped yourself from the only rope "life line."

Is it important to take *extreme risk*, like climbing Mount Everest, to be sucessful in life? Why or why not?

GLOSSARY

acclimatization The adaptation of the human body to decreasing oxygen levels found at high altitudes. It is a slow process, in which breathing, heart rate, and blood pressure are all affected.

altitude The height of something above a reference level, especially above sea level or above the earth's surface.

base camp Principal area of an expedition, usually placed at the start of the expedition.

Buddhism A religion started by Siddhartha Gautama (Buddha) who lived during the 5th century B.C. in India.

continental drift The concept of continent formation by the fragmentation and movement of land masses on the surface of the earth.

dehydration The loss of body fluid due to lack of water intake or to evaporation of body fluids.

frostbite A condition affecting the extremities, in which blood vessels become constricted due to ice crystal formations between cells; full treatment can be administered in hospitals with hyperbaric oxygen chambers.

Global Positioning System The use of satellites and earthbound receivers to plot the latitude, longitude, and altitude of any location on the earth's surface.

hypoxia A condition due to lack of oxygen at high altitudes; it is characterized by insomnia, nausea, irregular breathing, fatigue, dehydration, and loss of coordination, and can lead to pulmonary distress or even death.

jet stream A narrow band of upper-atmospheric wind often exceeding speeds of 250 miles (400 kilometers) per hour.

latitude Angular distance from the equator of any point on the earth's surface. The equator is 0º and the poles are 90º N and S, respectively.

longitude Angular distance on the earth's surface, measured east or west from the prime meridian at Greenwich, England, to the meridian passing through a position, expressed in degress (or hours), minutes and seconds.

mantra A mystical formula of invocation or incarnation found in the eastern religions.

massif A massive block of the earth's crust that is more rigid than the surrounding rocks.

plate tectonics A theory of global dynamics having to do with the movement of a small number of semi-rigid sections (plates) of the earth's crust, with seismic activity and volcanism occurring primarily at the margins of these sections.

prayer flag Long strips or square pieces of cloth printed with prayers whose messages are believed to travel to all parts of the world as the wind blows them.

prayer wheel Cylindrical wheel printed with prayers and having paper inside containing written prayers.

Sherpa Literally means "people from the East," designating a cultural group of Buddhist hill people. In lower case, sherpa refers to mountain guides.

snow blindness Temporary impairment of vision due to the glare of the sun reflecting off snow.

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Stan Armington, Australia, 1996.

ACKNOWLEDGEMENTS

We wish to recognize the following individuals who contributed to this study guide:

The Fleet Science Center, San Diego, California

Lynne Kennedy, *Deputy Executive Director, Education and Exhibit Programs*

Aly Evans, *Education Specialist*

Michaeleen Farrington, *Education Coordinator*

Educators

Susan Bernstein, *Former Education Director, San Diego Museum of Man*

Carol Radford, *San Diego Natural History Museum*

Margaret Schleicher, Steve Prendergast, *St. Charles Borromeo Academy*

Dennis Christian, *Miramar Ranch Elementary School*

Frances Cornell, *Bonita Vista Middle School*

Advisors

Dr. Pat Abbott, *San Diego State University*

Dr. John B. West, *University of California, San Diego*

Ross Clark, *Moss Landing Marine Labs & The Watershed Institute*

Design

Jeff Girard, *Victoria Street Graphic Design*

Illustration

Phil Roberts

MacGillivray Freeman Films, Laguna Beach, California

Alice Casbara

Thanks to Broughton Coburn, Audrey Salkeld, Roger Bilham, Charles Houston, Kevin Kowalchuk, Liesl Clark, Liz Cohen, Linda Marcopulos, Steve Judson, and Janna Emmel for their informative Everest Field Dispatches, and Myles Connolly, MacGillivray Freeman Films.

Special thanks to Marcello Mastrocola for sharing his Everest (1973 Italian Team) experiences with us.

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Major funding provided by the
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National Museum of Natural Science, Taiwan

Science World, British Columbia, Vancouver