Teachers' notes

Lesson notes

Snowshoe Math

1) Students will determine the surface area of snowshoes.
2) Students will calculate their PSI on a pair of snowshoes.

Evaluation

How long have snowshoes been around?
Snowshoes have been used for thousands of years. The current belief is that snowshoes developed in central Asia some 6,000 years ago. As people migrated from east to west, they brought their shoes with them. Along the way, changes were made for different types of snow conditions. Eventually, snowshoes evolved into skis in Scandinavia.

Snowshoe Review

Why were snowshoes invented?
People need to eat during the winter, too! They relied upon their hunting skills to feed their families. These hunters observed the feet of the animals, like snowshoe hares, that were able to travel easily in the deep snow and tried to mimic them for themselves.

Snowshoes

Snowshoes have been a part of the traditional culture in interior Alaska for more years than we can trace.

The design of snowshoes has varied from location to location, controlled mostly by the needs, conditions, and materials at hand.

Basic Idea

The idea behind snowshoes is fairly simple: Increase the surface area of a person's foot so they can walk on top of the snow rather than penetrating to the bottom. The number of snowflakes holding up the person is increased when the surface area is increased. Without snowshoes, the number of snowflakes is rather small. With snowshoes, the number of snowflakes is greatly increased.

This sounds easy, but designing a shoe that:

- is light and strong,
- will be comfortable to use in deep or packed snow,
- is easy to put on and take off,
- will keep the traveler on top of the snow, but
- won't accumulate snow on its surface.

All of these amount to an engineering feat.

Video Legend

Snowshoe design

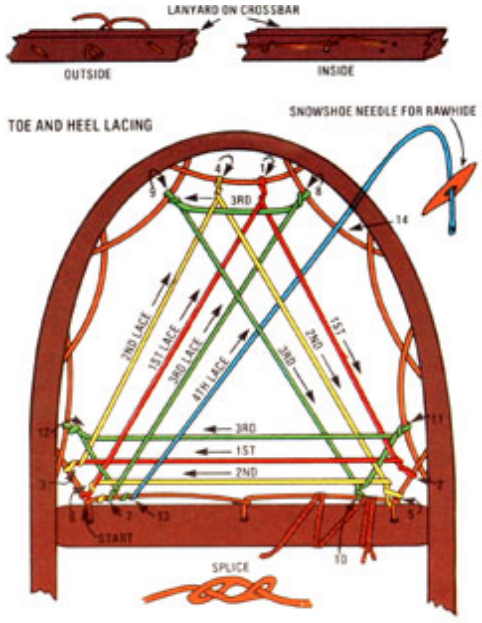
The first snowshoes were nothing more than bent twigs with rawhide lacing. Ash became the wood of choice, though birch, willow and spruce have been used, as well. North American Indian tribes are credited with perfecting the features with four distinct styles: Alaskan, Ojibwa, Michigan and Bear Paw.

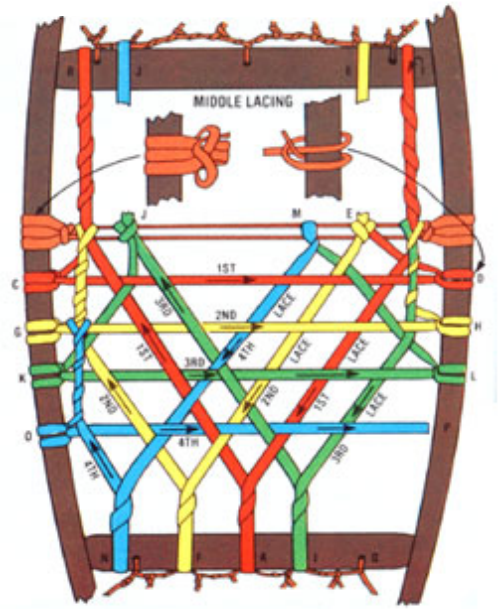
The long, narrow, and upturned toe of the Alaskan shoe all served a purpose. The wide, open spaces of the interior made for swift travel for which these shoes were adapted. The upturned toe was used to break trail for dog sled teams. These shoes commonly measured 10" x 60."

The canoe-like features of the Obijwa shoe were developed because of the variety of terrain the people traversed. These double-pointed shoes allowed the First Nations people, of what is now Manitoba, to cross their diverse territory with speed and ease. Walking backwards was even possible with this design.

The long-tailed design of the Michigan resembles a tennis racquet. While this long tail made turning around difficult, and sometimes tripped them up by getting caught on hidden undergrowth, the hunters were able to carry their heavy loads of elk and buffalo. Michigan shoes measured about 13" x 48."

The oval-shaped Bear Paw is the most versatile and is the design used in today's modern shoes. It is short and wide, making it easy to move through different terrain and to carry a heavy load. Because they have no tail, Bear Paw snowshoes are easy to turn around in. These shoes range from 8"x 25" to 10" x 36."





Size and Shape

How big should snowshoes be? If they are too wide, the person will walk bowlegged. If they are too narrow, they won't have enough surface area to support the traveler.

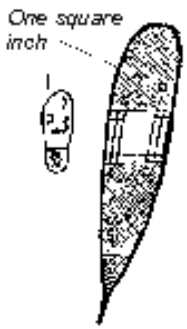
If they are too short, they will not have enough surface area to support the person. Traveling in soft snow will be very difficult. If they are too long, they will be too heavy, and difficult to use in the brush.

If they don't have enough turn-up in the front, they dive into the snow, and cause the traveler to constantly fall. If they have too much turn up, they won't provide enough area on a harder surface to support the traveler.

Two Types

There are basically two types of snowshoes, trail and bearpaw. Trail snowshoes are usually ten inches wide and fifty-six inches long including the tail. Bearpaws are shorter and rounded on both ends.

The front of trail snowshoes are upturned for deep powder snow. The rounded shape of the bearpaws give a little bounce to the traveler's step on hard packed snow, acting like a mini-trampoline.



PSI

The pressure that snowshoes exert on the snow can be described in pounds per square inch (psi). A heavier person will sink deeper on the same pair of snowshoes than a lighter person because the pounds per square inch of snowshoe surface is greater.

Both a lighter and a heavier person sink deeper in powder snow because the strength of the snow is less than the strength of packed snow.

The optimum size of snowshoes depends on the traveler, snow conditions, and use. If the traveler is fairly light or usually travels on hard-packed or drifted snow, small shoes will be enough.

Once the traveler sinks deeper than his knees, traveling becomes very difficult. In powder snow, I have never found a pair of snowshoes that I thought were too big except in a few experiences fighting through brush.

Oldtimers purposely used smaller snowshoes to break trail a good trail for dogs or other people following behind.

When they ran down a moose, they often used very large snowshoes (six feet) to stay on top of the snow and conserve their energy.

Steps to finding out our PSI:

1) Determine the surface area of your foot by using 1 inch graph paper. Multiply it by the number of feet you have.

2) Determine your weight by using the bathroom scale.

3) Divide your weight by the surface area of your foot to determine your PSI without snowshoes.

Steps to finding out our PSI on snowshoes:

1) Determine the surface area of a snowshoe by using 1 inch graph paper. Multiply it by the number of feet you have.

2) Divide your weight by the surface area of your snowshoe to determine your PSI on snowshoes.

Math

1. What is the psi of a person weighing 175 lbs on snowshoes that have 400 square inches.
2. What is the psi of the same person wearing boots with 48 square inches? Snowshoes increase the surface area the person is exerting force upon by how many times?
3. On a trail snowshoe, measure the surface area in front of the individual's toe. Measure the surface area behind the individual's heel. Which is greater?
4. Compute the psi of the smallest person in the class if they have a standard pair of 10" x 56" snowshoes. How big would the snowshoes have to be for the largest person in the class to have the same psi therefore sinking the same distance into the snow? You will have to figure the area of the snowshoes out in several different parts, circles, squares and triangles.
5. A homemade snowshoe weighs 2.2 lbs. Another one made by the Army is 3.0 lbs. If someone's step is 2' and there are 5,280 feet in a mile, how many extra pounds are lifted in a mile? How many extra pounds are lifted on a hunting trip where the person walks 7.4 miles?

Procedure:

1. Have students trace their boot on centimeter graph paper.

2. Since the boot does not have straight edges, some estimating will be necessary. Ask the students to count the number of square centimeters covered by the boot surface. Also have the students count the squares that are more than one-half included inside the outline of the boot, but caution students NOT to count squares that are less than one-half included.

3. Ask the students what they think it is that makes you sink into the snow. (Elicit weight, pressure, quality of the snow--packed or loose). What relationship can students think of between weight and sinking in snow?

4. Measure weight in kilograms of all students individually. Use the same scale for everyone (nurse's office, airline office).

5. Can students think of a numerical relationship (ratio) between the area of their boot and their weight? Call it pounds per square centimeter (psi) or "sink in the snow factor." Ask all students to find their own sinking factor (division required!)

6. Then ask students to find the square centimeters covered by a moose print (provide track outline). And the sinking factor of a cow moose that weights 800 pounds.

7. Students then do similar exercise finding the area in square centimeters of a pair of snowshoes.

To figure the psi of a snowshoe, you would estimate the area of the snowshoe:

a) area of a rectangle = length X width = sq. in.

b) area of a triangle = 1/2 (base X height) = sq.

c) area of second triangle = 1/2 (base X height) = _

d) area of the snowshoe = a + b + c = sq. in.

8. Find sinking factor of snowshoe hare, lynx or ptarmigan prints (provide track outline) and find sinking factor of each.

9. Have students compare boot to moose print, snowshoe to hare, lynx or ptarmigan to see which kind of animal can move efficiently through snow. What characteristic about snowshoes and large feet might cause users to stay on top of the snow better?

10. Can you think of any other modes of transportation that use this same idea of psi? Or any other areas of daily life? (skis? snow machines? dog sleds? See Alan Dick's *Village Science*, p 192)

Enrichment:

11. Calculate the psi of a stiletto style high heel and compare to the psi of your boot.

What conclusion can you draw about the relationship between surface area and psi?

Lesson 7 - Improvised Survival Snowshoes

Learning Goal: Students will use materials at hand (natural materials: spruce boughs, willow, etc.) and collected materials (recycled cardboard, plastic or other tubing, etc.) to make survival snowshoes. Students will summarize in journals and make a presentation to interested family members regarding what they learned about snowshoes.

Materials: cardboard, tubing, boughs, willow wands, traditional snowshoes, KWL chart from first activity, journals

Procedure

l) Students collect natural and recycled material useful for making survival snowshoes.

2) They then construct a pair of snowshoes from the materials.

3) Test out the snowshoes by holding races with the improvised snowshoes. Include traditionally made snowshoes if desired for comparison.

4) Judge the snowshoes in two categories: a) traditional, b) improvised. Have elders and peers judge effectiveness.

5) Students with teacher complete the KWL chart that was started at the beginning of the unit. Students make presentation to parents and/or community members about their findings and experiences.

Snowshoe softball?

Attachments

Snowshoe lessons

SnowshoeVid.mov