Lesson Plan: Making Snow Goggles

The students will make snow goggles similar to those used by ancient Inuit hunters and observe their properties. By using the scientific method to come to the idea of making the goggles, the students become familiar with the same process used by spacecraft designers.

Preparation

- Conduct this activity on a sunny day. (This may not be necessary but it makes the point clearer.)
- Have students work in groups of three.
- If desired, make transparencies as well as hardcopies of the Student Worksheets and the MESSENGER Information Sheet for classroom explanations (one per student).

Warm-up & Pre-assessment

1. With the whole class, conduct this brief brainstorming activity in no more than five minutes, to get students thinking about (and defining in their own words) the problem. (I.e., excess sunlight can cause blinding conditions that make it difficult or impossible to see well.)

2. In large letters on the blackboard or on a flipchart, make three different columns and label them:

SUN SUNGLASSES HUNTERS

Have students write down on their paper anything they know or can associate with each word. Give them two or three minutes.

3. Call for the students' ideas, and write them on the board.

4. Ask students to make a connection between all three categories by asking, for example, "How are these things related?"; "Is there a problem they share in common?"; or "Can you make a sentence out of the phrases and words from each column?"

Materials

Per student:
- 1 page of notebook paper
- Snow goggle cut-outs from Patterns A and B, preferably printed on cardstock, foam core, or cardboard
- Scissors

Per group of three:
- 2 meter sticks
- 2 chairs
- Scotch tape
- Optional: Xacto knife, hot glue gun (only needed with foam core or cardboard)

Per class:
- One pair of sunglasses (for demonstration only)
- Blackboard or flipchart with markers

Teaching Tip

Student answers should include the need of sunglasses to reduce bright sunlight, and that a hunter would benefit from them as well. Cue students with questions such as, "Where can you find hunters?" or (if it is a bright day): "Look outside—BUT DO NOT LOOK DIRECTLY AT THE SUN—How would your eyes feel if you had to stare out across a snow-covered field looking for something all day?" to remind them of some conditions under which hunters (or outdoor laborers and athletes) work.

PROCEDURES

1. Discuss the problem that the students identified based on thinking about the Sun, sunglasses, and hunters in the Warm-up. Point out that they had just begun step 1 of the Scientific Process: "Stating a problem." Outline the rest of the process below, or paraphrase as needed. Using the scientific process, a scientist:

1) states a problem;
2) forms a hypothesis;
3) experiments;
4) observes the results of an experiment;
5) revises the hypothesis or concludes that it is acceptable.

Remind the students that hypothesis is not the same as established theory. A hypothesis must be tested and accepted to become part of larger body of knowledge, the general theory of the subject.

2. Tell the students that they will use this process to solve a problem in class, and then they will be asked to solve another problem: one that has to do with traveling in space!

3. Pose the following problem to the students:
SITUATION: Imagine that you are a 19th century hunter, trying to spear a seal on the arctic ice in springtime to feed your family. Near the North Pole, where everything is covered by snow and ice, it is bright in all directions. There is so much light and glare from the sky and reflected from the snow-covered ground, that you can become snowblind.

PROBLEM: How do you get rid of the excess light you do not need, but keep the light you do, so that you can still see the seals (and so that you don't accidentally bump into a polar bear)?

4. Point out limitations, such as there being no Polaroid lenses in the 19th century, and that excess light is not a new problem. Tell students that in fact, a solution was found centuries ago by the Inuit people of North America, Greenland, Europe, and Asia.

5. Brainstorm ideas together as a class, writing them on a chart so that all can see. Choose the best educated guesses, and form one or more hypotheses, which is step 2 of the scientific process. (Possible answers: Hats that block the Sun completely; sunglasses that filter or block certain rays/colors; facial coverings to block peripheral light; tinted mirrors to reflect away some light; tents & canopies.)

6. Discuss the practicality of the ideas, in terms of whether they could be tested and proven right or wrong (i.e., whether they are falsifiable), and whether the necessary materials would be available at that time in that region. Keep a record of students' suggestions. If necessary, prompt: "If you use an eye protection device to block some light and just look through a hole you may not see well without moving your head. This might not be ideal if you are hunting and you want to stay absolutely still. How can you solve this?"

7. Tell the students they will now proceed with scientific process step #3, to experiment with one of the hypothetical solutions to the stated problem. If no one suggested a solution similar to the snow goggles, you may have to introduce it here.

8. Place students in groups of three. Hand out worksheets, snow goggle patterns, scissors and tape. Have students cut out and assemble snow goggles. Ensure that each group makes at least one of each pattern A and B.

Teaching Tip

Show students how to make a slit in the goggles by folding the paper gently at the half-way point, and cutting half the slit with its other side. Note that patterns A and B look very similar but they have a different slit size (A: 5 mm, B: 7 mm). Make sure the slits are accurately cut.

9. Have students label the goggles with their names (and, if desired, a team name and colors).

10. Ask students to hypothesize as to how each pair of goggles will work, whether one version is better than the other at protecting the eyes and improving vision, and if so, under what circumstances. Have the students write their ideas on paper so that they can compare their guesses with actual observations later.

11. Have students completely read through and follow the instructions on Student Worksheet 1, conducting the experiment and filling in the data as a group, but answering questions individually.

Teaching Tip

Show students how to test their field of view, by ensuring that the Viewers do not move their head or eyes. Have the Experimenter hold the meter stick vertically. If the numbers are not easily readable, hold up a certain number of fingers at differing heights, and mark the stick with tape at the highest and lowest points seen by the viewer.

Discussion & Reflection

1. Regroup the class to discuss the observations students made during their experiments.

2. As students contribute comments, conclude that the amount of light coming to their eyes is reduced by the goggles. How much it is reduced can be calculated, and if there are students interested in finding out how to do this, tell them they can complete Student Challenge Worksheet 1 at the end of this lesson. Other students may want to estimate what fraction of the light is reaching their eyes, based on the size of the slit in the goggles. (With these goggles, about one-third of the light reaches their eyes, which is quite enough for a hunter to see well on snow and ice.)

3. Remind students of their original hypotheses regarding the arctic hunter, and ask them to discuss the importance of light in his/her life, including length of day and night, intensity of the Sun at different times of day and year, reflection on snow or ice, etc. Ask if the students' experiments allow them to accept their hypotheses or if they need adapting.

4. Have the students describe their results and the application of their results to everyday life.

(This next section may be assigned as homework, or may be continued in a second class meeting, if more time is needed.)

5. Tell students that, as they solve the problem of reducing excessive sunlight on Earth, they have been going through the same way of thinking, that is, the same "Scientific Process," that will help them figure out how to reduce excessive sunlight in almost any situation, including in space.

6. Using the MESSENGER Information Sheet either as an overhead or as student copies, read through the description of the spacecraft and its mission.

7. Have students list similar problems that both MESSENGER and the arctic hunter might have in common. You may want to do a brief brainstorming with three columns on the board, as you did in the Warm-up. Write:
MESSENGER SUN ARCTIC HUNTER
on the board, and give students two minutes to come up with words they associate with each.

8. Call for the students' ideas and demonstrate how the class is using the same scientific process to solve a different problem. It is important to point out that the same object (in this case, the Sun) can cause many different problems and that each may require a different solution. In any case, the scientific process will guide the scientist. A scientist:

1) states a problem;
2) forms a hypothesis;
3) experiments;
4) observes the results of an experiment;
5) revises the hypothesis or concludes that it is acceptable.

Assign as homework or as extra credit the problems found on Student Challenge Worksheet 2.

Lesson Adaptations

For students with coordination problems, have a team member cut out the goggles.

Extensions

- Challenge students to design a better pair of goggles. (They may want, for example, an extra, foldable visor for changing light conditions, or to serve as multipurpose goggles that may also protect against UV radiation, wind, glare, etc.)

Have students answer the following essay questions:

- Explain why sometimes you need to reduce the amount of sunlight reaching your eyes; describe at least three places where this might be true. Explain what you might have used to protect your eyes in the 19th century, and compare that with what you would use today.

- List at least three things that are good for you in the right quantity, but that if you have too much of them, they become bad for you. Explain how you would reduce the excess amounts of each, and if your solution is practical or not.

- Look at pictures of the MESSENGER spacecraft and research it on the Internet. Describe the general conditions in space, and explain which conditions create problems for equipment.

- Describe the general conditions in space, and, using the scientific method, design solutions to at least two of the problems that prevent humans from easily living there without a great deal of protection and support.

Curriculum Connections

- *Social Studies:* Find out the history of Inuit hunters, and challenges they faced in dealing with harsh weather, difficult living conditions, limited tools or weapons, and dangers. Research different kinds of snow, ice, light and cold protective gear at different locations around the world.
- *Mathematics:* Have students complete Student Challenge Worksheet 1 on Field of View.
- *Technology/Industrial Design:* Have students hypothesize as to the ideal amount of light needed for the eye to distinguish certain details such as water, fire, mountains, craters, metallic objects, etc. in different environments such as in a cave, on an ice sheet, in a desert, or out in space.
- *Art and Design:* Have students compare the style of snow goggles to other kinds of eye protection used in different professions, and then identify the best elements of each that might be incorporated into a more functional and aesthetically-appealing design.

Assessment

4 points

- Student completed experiment in Student Worksheet 1.
- Student listed valid advantages and disadvantages of snow goggles (numbers 3 and 4 in Student Worksheet 1).
- Student justified their answer as to which pattern they would use, A or B (number 8 in Student Worksheet 1).
- Student correctly answered all remaining questions in Student Worksheet 1.

3 points

- Student met three of the four criteria from above.

2 points

- Student met two of the four criteria from above.

1 point

- Student met one of the four criteria from above.

0 points

- No work completed.

Closing Discussion

Review with the students situations where excess sunlight can be a problem. Remind students that they have used the scientific method in two different contexts: designing snow goggles for hunters in arctic regions in springtime, and for spacecraft exploring planets close to the Sun. Discuss with the students how the same method can be used in a variety of situations. Review with the students the reasons why the scientific method makes science so robust in providing solutions to a variety of problems.

Internet Resources & References

MESSENGER website

http://messenger.jhuapl.edu

A Journey Through Canadian History and Culture: Snow Travel in Ancient Canada

http://www.civilization.ca/educat/oracle/modules/iandyck/page01_e.html

Alaska Native Heritage Center

http://www.alaskanative.net

Alutiiq Museum and Archaeological Repository, Kodiak, Alaska

http://www.alutiiqmuseum.com

American Association for the Advancement of Science, Project 2061 Benchmarks for Science Literacy

http://www.project2061.org/tools/benchol/bolframe.htm

National Science Education Standards

http://www.nap.edu/html/nses/html/

Smithsonian Institution: "Looking both ways," an exhibit of the Smithsonian Museum of Natural History

http://www.mnh.si.edu/lookingbothways

Smithsonian Museum of Natural History, Arctic Studies Center web resources

http://www.mnh.si.edu/arctic/html/resources.html

University of Alaska Museum: Artifacts from St. Lawrence Island

http://www.uaf.edu/museum/depts/archaeo/pages/gallery/stlwrc_01.html