ACTIVITY: DRESS LIKE A PENGUIN

BY ANNIE THOMPKINS GUNTER AND DANIEL DICKERSON

The following lesson focuses on adaptation, insulation, and penguins and was developed to complement the science of the US Southern Ocean Global Ocean Ecosystem Dynamics (SO GLOBEC) Program. The goal of the SO GLOBEC program was to understand the environmental and biological factors that influence the growth, reproduction, recruitment and survival of Antarctic krill (*Euphausia superba*). Studies of the predators of Antarctic krill, such as penguins, seals and whales, were integral to this goal.

FOCUS
Adaptation, insulation, penguins

GRADE LEVEL
5-8 (Life Science/Physical Science)

FOCUS QUESTION
How can penguins survive the extreme cold of the Antarctic?

LEARNING OBJECTIVES
Students will be able to define structural adaptation and explain in general terms how this helps animals survive in extreme environments.
Students will be able to explain insulation and identify insulating materials
Students will be able to explain how penguins survive in cold environments and will be able to discuss how this might be affected by environmental change, such as a warming climate.

MATERIALS
- Containers (alike with openings large enough to add water and insert temperature probes/thermometers)
- Funnels (optional)
- Temperature probes/thermometers
- Shortening/petroleum jelly
- Hot water (measure the same amount for each group)
- Measuring cup with handle for hot water
- Wrapping materials (cotton, fur, wool, newspaper, aluminum foil, nylon, paper of different colors, etc.)
- Tape (duct, transparent, masking)
- Beaker/plastic box (large enough to place containers to prevent spillage)
- Paper
- Pencil

AUDIO/VISUAL MATERIALS
Computer
Projector
Whiteboard/Chalkboard

TEACHING TIME
Two 45-minute class periods, plus time for student research

SEATING ARRANGEMENT
Groups of four

MAXIMUM NUMBER OF STUDENTS
The maximum number of students is based on the amount of supplies available.

KEY WORDS
Antarctic
Penguins
Anatomy
Physiological Adaptation
Insulation
Predator
Warm-blooded
Endothermic

BACKGROUND INFORMATION

Content: Penguins are warm-blooded animals (birds). The body temperature of a penguin is about 39°C (about 102°F) and must be maintained for survival. All animals get thermal energy from the food they eat. Internal and external structures such as fat skin and feathers allow them to maintain a balance between the heat produced and the heat lost. Animals usually choose an environmental temperature close to what can be maintain by their anatomical and physiological structures. The type of activity the animals engage in and shivering also help regulate heat production. Thermal insulation can be changed by increasing or decreasing blood supply and feather arrangement. For background information about thermal insulation specifically for penguins, use the following website: http://www.pinguins.info/Engels/Warmtebehoud_eng.html. The "Science of the Cold" website, which has a section on "How penguins survive cold conditions", provides useful general background information: http://www.coolantarctica.com/Antarctica%20fact%20file/science/cold_penguins.htm. Additional general information on cold survival is given at the "Antarctic: 90 Degrees South" website: http://westernreservepublicmedia.org/antarcti/insulat.htm.

Pedagogy: The "Dress Like a Penguin" activity is an inquiry-based, technology-enhanced lesson designed to teach upper elementary/middle school students about how penguins can stand such a cold environment. Specifically, the lesson employs a 5-E Learning Cycle structure characterized by the following lesson components: Engage, Explore, Explain, Elaborate, and Evaluate (BSCS, 2006). Additionally, the lesson incorporates instructional technologies (e.g., probeware). Where such technologies are not available, the low-technology equivalents may be used. However, the use of the low-technology equivalents is likely to require additional time to complete the activity and is often less accurate and precise.

LEARNING PROCEDURE

Engage

1. To prepare for this lesson you could do one or more of the following:
    a) Show a clip from a penguin video/movie to get the students excited about the animals they are about to explore and ask them to describe some observations they made from the clip. Be sure that the video/movie does not provide explanations about penguins' insulation. At this point we want the students to use their brains and start asking questions.
    b) Have a non-graded pretest that may include questions about:
        How do penguins survive in extremely cold environments?
        What is insulation and how does it work?
        How might a warming climate impact penguins?
        What type of animal is a penguin?
        Are penguins warm- or cold-blooded?

Explore

1. Tell the students that in this investigation, "Dress Like a Penguin", the goal is to build a container that helps prevent heat loss. Explain that the materials selected and the final design must be agreed upon by the group. They can try any design they want as long it uses one or more of the materials in their kits.
2. Divide the class into groups based upon materials available and class size.
3. Distribute the kits of materials to each group.
4. Tell the students what each item in the kit is (you may want to ask how certain items are used in daily activities, but do not tell the students about any insulative properties).
5. Have each group brainstorm and illustrate its design on paper.
6. Using their drawings, have the students fashion their containers. **A time limit is suggested for design and construction, but be sure to allow for multiple trials and designs.**
7. Place completed design in a beaker large enough to prevent spillage.
8. Pour measured hot water in the opening of the container (Teacher assisted).
9. Place the temperature probe/thermometer in the container and measure the temperature immediately. Record the temperature after obtaining a constant reading. The thermometer should not touch the bottom/sides of the container.
10. After each 1-minute interval (5-minute intervals if using alcohol thermometers), measure and record the temperature.
11. On a large piece of paper, have the students draw their design and list the materials used in their design on the top half of the paper. Then ask them to draw a graph showing their collected data on the bottom half of the same piece of paper. The papers can be placed around the room so everyone can see them.

Explain

1. Have each group make a presentation on its design and findings.
2. Ask the students to vote on which design was best at preventing heat loss.
3. Define insulation and use the students' designs as examples to illustrate your definition.
4. Explain to students or have them find explanations online about the following:

    a. Penguins are birds and warm-blooded

b. Penguins are insulated with a layer of fat and this helps them survive the cold
c. Feathers are uniquely structured; cold climate penguins have longer feathers and thicker fat
d. Colors absorb or reflect heat (refer to the penguins feathers being black and that this helps them survive the cold)

5. Briefly introduce the Southern Ocean GLOBEC program and how it helps us understand more about climate change. Talk about what warmer temperatures in the Antarctic could mean for an animal that is designed to stay warm.

Elaborate

1. Have each student draw a picture and write one paragraph about a bird that they discovered while on an expedition to Antarctica. Tell the students that this bird has never been seen before so they will have to describe it to the world because their camera was broken during their dangerous adventure. Tell them to be sure to use what they learned about surviving in the extremely cold Antarctic environment when thinking about their bird, because if it does not have those characteristics people will question how it could survive and say that you are just suffering from "Cold Crazy".
2. Have students write a second paragraph describing how a warming climate would impact their bird and what they plan to do to help their bird's species survive.
3. Review these at home and re-teach as needed.

Evaluate

1. Once you feel confident the students can meet the objectives, provide an evaluation such as the following:
   a. Have students write a brief essay describing why they should care about penguins and what might happen to penguins if the Antarctic gets warmer.
   b. Have students list and describe the clothing and items they would include in a survival kit for the Antarctic cold and explain why.

THE BRIDGE CONNECTION

The following web sites provide extensions of this activity:
http://expertvoices.nsdl.org/polar/2008/04/28/pierre-the-penguin-teaching-about-heat-and-insulation-through-adaptations/
http://westernreservepublicmedia.org/antarcti/howtouse.htm
http://www.pinguins.info/Engels/Warmtebehoud_eng.html.

THE "ME" CONNECTION

Have students write a brief essay describing why they should care about penguins and what might happen to penguins if the Antarctic gets warmer.

Have students list and describe the clothing and items they would include in a survival kit for the Antarctic cold.

CONNECTIONS TO OTHER SUBJECTS

English/Language Arts, Mathematics

ASSESSMENT

Written reports and class discussions provide opportunities for assessment.

EXTENSIONS

Have students visit online and explore the different types of penguins

Have students conduct the experiment, "Dress like a Penguin" using containers of the same shape but different sizes.

MULTIMEDIA LEARNING OBJECTS

Additional learning websites that are relevant to this activity are:

http://www.coolantarctica.com/Antarctica%20fact%20file/science/cold_penguins.htm

http://www.pinguins.info/Engels/Warmtebehoud_eng.html

OTHER RESOURCES

WHRO | The Public Telecommunications Center for Hampton Roads, Nature"Penguins of the Antarctic"

http://www.seaworld.org/infobooks/penguins/home.html

NATIONAL SCIENCE EDUCATION STANDARDS

NS.5-8.1 SCIENCE AS INQUIRY
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

NS.5-8.2 PHYSICAL SCIENCE
- Transfer of energy

NS.5-8.3 LIFE SCIENCE
- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

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