Construct-a-Glove

Developed by TERC
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INSULATED GLOVE DESIGN BRIEF

In this activity, you will be researching, designing, building, and improving an insulated glove system. You will use both technological design and scientific inquiry as processes to investigate and improve the performance of your prototype.

Your Design Challenge
As a member of a product research and development team, design an insulated glove system that keeps the tip of your index finger as warm as possible in uncomfortably cold surroundings, while maintaining dexterity for a specific function.

Scope of Work

Quick-Build: Build and test an initial glove design according to instructions.

Research: Investigate heat transfer and insulation and identify variables you can control to create an improved insulated glove.

Development: Specify function, redesign, build, and test; collect data and analyze patterns of results; then finalize your prototype for critical review.

Communication: Present a product prospectus that summarizes your team's final design, including documentation such as sketches, data, specifications, and limitations.
What I already know about Homeothermy, Heat Transfer, and Research and Development.

The unit of study you are about to begin will challenge you to design, build, and performance-test a prototype model of an insulated glove. To meet the performance specifications, you will have to investigate heat transfer physics, biological temperature regulation, and insulative effectiveness of materials and configurations. Before you begin, record a sample of what you already know by answering the questions below. This is not a test; rather it is a series of questions that ask about your current knowledge of key ideas in this unit. At the end of the unit, you will answer similar questions, and compare what you have learned.

1. What are the parts of the hand?

   (a) What are the functions of a hand (e.g., sensing, temperature regulation, manipulation, etc.)?

   (b) Make a sketch of a hand and label the important parts and functions.
2. List as many special purpose kinds of gloves as you can. Place a “T” by those specifically designed to provide thermal protection.

<table>
<thead>
<tr>
<th>Example</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding</td>
<td>T</td>
</tr>
</tbody>
</table>

3. Think of a time when your hands were really cold. What were you trying to do?

How did you warm them?

Which heat transfer process did you use? (e.g., radiation, conduction, convection)

4. What test(s) could you perform to determine if an animal is “warm-blooded” (homeothermic) or “cold-blooded” (poikilothermic)?

5. To maintain your relatively constant body temperature of 36°C, what does your body do automatically?

What are some things you do purposefully to make yourself warmer or cooler?

6. What are **temperature** and **heat**, and how are they related?
**Teacher Pages: Activity 1**

**MATERIALS**

Student Activity Sheets
- Course Outline
- Insulated Glove Design Brief
- Snapshot of Understanding

Ring, Pocket, or Folio Binder
- (student supplied) for keeping student activity sheets, notes, and drawings for reference and portfolio assessment

**PREPARATION**

- Read and become familiar with the entire unit.
- Prepare an introduction to motivate student interest.
- Define your assessment system with a clear, simple description.

**OVERVIEW—DESIGN BRIEF**

Give students the Insulated Glove Design Brief and the Snapshot of Understanding. Initiate class discussion and highlight important design issues.

**Construct-a-Glove Challenge to Students**

Each student, as a member of a product research and development team, is to design an insulated glove system that keeps the tip of the index finger as warm as possible in uncomfortably cold surroundings while maintaining dexterity for a specific function.

Students write short answers to questions about their prior knowledge of heat transfer, body temperature regulation, and research and design processes. (20 minutes suggested.)

**TEACHING SUGGESTIONS**

**Introduction**

Hand out the Insulated Glove Design Brief student activity sheet. Ask students to keep these and future sheets together in one place and to bring them to the classroom with other notes to serve as a record and reference for daily activity (and assessment) in the unit. Advise students that they will work in teams, use processes of technological design and scientific inquiry together, and that other teams will critique their prototype with respect to the challenge criteria. Students are also required to document their activity in order to both contribute effectively to the final team presentation and to enhance their individual portfolios. Be clear on your rubrics for assessing their work and share them with students. Indicate which activities will be individually graded and which will be given a team score. Be prepared to justify team scoring if some students (or parents) are not used to the idea.

**Issuing the Construct-a-Glove Challenge**

We encourage you to expand the challenge to accomplish additional learning objectives but be careful to think through what will be involved.
For example, a criterion of dexterity (such as the ability to pick up a marble with the insulated glove system) might be added to enrich the challenge if robotics or finger function is pertinent to your course objectives. But this addition will demand more sophisticated technical materials, involve greater construction difficulties, and require more student time.

**Other Possible Criteria**

- Let students specify the dexterity they have achieved after-the-fact, in their product prospectus.

- Let teams choose to design for one of several simulated bid invitations. You will need to prepare the bid request document (be sure to include dexterity task specifications).

- Set one uniform standard for all teams to achieve with the gloved hand immediately following a standardized immersion time in ice water. Example tasks might be picking up a pencil off a flat surface, operating a camera, using pliers, holding a nail for hammering, tuning a radio, using a keyed lock, placing a nut on a bolt, etc.

- Set a theme such as survival in snow country; orient toward natural insulation materials such as leaves and grasses that can be gathered outdoors; and specify necessary hand functions such as gathering firewood and signaling for help. (Define or supply the range of options so as not to damage the local environment.)

**Pre-Assessment**

Hand out the *Snapshot of Understanding*. Emphasize that this is not a test, and they will not be graded on this activity. Its purpose is self-diagnostic, to find out what they know initially about the unit’s key science and technology learning objectives. Making an inventory of their prior knowledge is an important learning tool. Not only can the inventory help to guide their learning toward the areas where students need to learn the most, but it also prepares their minds to accept new information in a manner that ties it meaningfully to what they already know. At the end of *Construct-a-Glove*, students will be able to compare answers to Snapshot questions given at the beginning of the unit to those they will answer at the end of the unit.

Allow about 20 minutes for students to complete the Snapshot, then collect and retain.
In the *Snapshot of Understanding*, students list as many special-purpose gloves as they can, given one example (welding). Some additional examples are:

- staining/painting/waxing
- food handling
- gardening
- dish washing
- skiing
- driving
- diving
- golfing
- meat cutting
- boxing
- baseball
- hockey
- fashion
- surgical
- wood cutting
- mountain biking
- cattle roping
- chemicals handling
- fire fighting
- traffic directing
- electrical line working
- space walking
- hunting
- archery
- ice fishing
- mountain climbing

Encourage a class discussion of differences among special purpose gloves; this can help students better relate form to function.