GENESIS SEARCH FOR ORIGINS Education

Heat: An Agent of Change

Survival!

TEACHER GUIDE

BACKGROUND INFORMATION

An insulated container should work equally well to keep hot things hot or cold things cold. The purpose of this activity is to create a "Survival!" container that will prevent heat transfer. It taps into the students' natural competitive instincts and encourages them to apply the knowledge learned in this module.

It is up to the teacher to decide upon the object or material that is to be protected in the survival container. One possibility is ice. On a hot day, with the containers pre-constructed the day before, you could use a single ice cube and determine how much melts during one class period. On a cooler day, or if the ice must survive until the following day, a larger piece of ice made in an empty yogurt container or some such mold may be more appropriate.

Another possibility is a boiled egg. If the eggs are put into the containers right out of boiling water, their heat content may be measured after a pre-determined time (perhaps 20 minutes) by immersing them in a known volume of known temperature cold water, and recording the increase in temperature of the water. (More temperature increase shows better insulation.)

Changes in science occur as small modifications are made to existing knowledge. The change in understanding from caloric theory to thermodynamics, for example, shows this growth in science as a discipline. This activity seeks to show students the value of expanding their scientific knowledge by inquiring how a container can insulate an object. The daily work of scientists and engineers results in small advances in our understanding of the world and our ability to meet human needs and desires.

STANDARDS ADDRESSED

Grades 5-8

- Abilities Necessary to do Scientific Inquiry
- Understandings about Scientific Inquiry
- Abilities of Technological Design
- Understandings about Science and Technology

Science in Personal and Social Perspectives

- Risks and Benefits
- Science and Technology in Society

History and Nature of Science

- Nature of Science

Grades 9-12

- Abilities Necessary to do Scientific Inquiry
- Understandings about Scientific Inquiry
- Abilities of Technological Design
- Understandings about Science and Technology

Science in Personal and Social Perspectives

Natural and Human-induced Hazards

Science and Technology in Local, National, and Global Challenges

History and Nature of Science-

Historical Perspectives

MATERIALS NEEDED

Ice (or eggs in boiling water)
Variety of insulating materials
Duct tape
Spray paint
Thermometers
Wood and cardboard scraps
Other items suggested by student design teams

PROCEDURE

1. Divide the class up into teams of 3–4 students each. Assign teams so that they contain members from the various teams used during "Activities with Insulators and Conductors." The information learned in that activity is relevant to this one, and intermixing students allows a jigsaw-like sharing of information.

2. Explain to students their role as members of a Product Design Team (PDT). Introduce the communication concept of a designer's notebook and a final report (see "A Design Process for Science Classrooms." Review each of the three primary components in product development: design, production, and testing.

3. Ask the class to suggest simple and practical products that might be designed to accomplish a task. Select one of these and briefly carry out the design process with the entire class. Be sure to address each of the considerations involved in the process, and have students take notes on the discussion. **Note**: Do not use a product similar to the one in the previous activity or to the one coming in this activity.

4. Out of the remaining list, have each PDT select one product they can use to take through a "trial run" using the design process. Each group should operate independent of the others and with very little assistance from the teacher. Tell students to make some decisions regarding how to assess their product and have them explain their reasoning. Designing a student-level rubric might be appropriate before continuing.

5. Review the results of the mini-designs, and request that other students or PDTs respond or critique the outcomes for each group. Clarify any misunderstanding before moving directly into the survival container designs.

6. Explain to students what materials they will be using to design their containers, and the requirements for conducting work within their PDT. Make clear at the outset the desired outcome of this activity: the correct application of the design process. Sharing "The Design Assessment Checklist" with students is a good way to do this.

7. Explain the criteria for the products students are to build. You may tailor criteria for your particular classroom situation, but the following represent a few frequently used parameters:

Container:

- The container must conform to specific outside dimensions; it may not exceed specified weight (mass) limits.
- The container must be a closed system; no additional energy may be added to the system after the object is placed in the container.
- Any materials may be utilized and any structural design is permitted, as long as basic safety rules and the stated limits on structural dimensions and mass are observed.

Team:

- PDTs will be formed by the teacher and will be composed of members of various R&D groups who experimented with possible construction materials in the “Activities with Insulators and Conductors.”
- PDT members will be assessed for group and individual work. The teacher will assess as construction is in progress, and the group and individuals will self-assess during and after construction.
- A written and oral presentation describing the materials and structural design of the container will be made by the group. A summary of the decisions made by the group and the justification for the decisions should be included. Any problems that were solved by the group should be reported. (This presentation will be a major percent of the group and individual grade. In other words, even if the object does not survive, a construction team that can show evidence of learning can still receive a satisfactory grade.)
- The teacher will determine the number of class periods allowed for team planning and construction. All work will be done at school. Outside consultation is allowed, but no outside help on construction unless authorized by the teacher.

8. Students and teacher can judge the success of designs by the amount of solid ice remaining when the container is opened (or the temperature of the water in which the egg is placed). If desired, the mass of ice remaining can also be measured and considered for further team recognition.

9. Monitor progress and provide assistance and appropriate timelines. The openness of the activity requires flexibility and a willingness to consider all assessment options and various needs and situations of different PDTs.

ADDITIONAL LEARNING OPPORTUNITIES

Create a container that not only survives heat transfer, but also protects the contents from the shock of hitting the ground during a drop test from a predetermined height.

Research important aspects of NASA “client” relations and project reviews, contractual arrangements, etc.

ASSESSMENT OPTIONS

Assessment of student understanding should come from multiple sources, and should address as many phases and considerations of the process the students are learning as possible. Student understanding of the design process and tools, ability to identify requirements or criteria and design appropriate products to address these criteria, prototyping the design, and evaluating the design through application to a project, are all important aspects, and should therefore be assessed separately. The activity “Survival!” encompasses both actual manipulation of materials and communication of results. The options for assessment given by the Design Assessment Checklist address those facets.

RESOURCES

A Design Process
Design Assessment Options

http://fytqm.uafadm.alaska.edu/PCFair96/state/state_handbook.html
The International Science and Engineering Fair (ISEF) Student Handbook for Precollege Science and Engineering Projects is a valuable resource.

http://inf2.pira.co.uk/use-bck.htm
A British site on user-centered design, a process to create products that are easy to use and match the needs of the users.

http://usfirst.mv.com/uscga/html
The U. S. FIRST engineering design competition teams high schools with local industry and university partners.

http://www.designinfo.com/RefLibrary/CDS/guide.htm
A humorous version of Murphy's Laws as applied to PDT work.

http://www.ee.washington.edu/class/engr100/concept.html
Guidelines for PDT poster presentations of conceptual product designs.

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DESIGN ASSESSMENT CHECKLIST

The following check list can be used to assess the "Survival" design activity. There will be 25 possible points. If further detail is desired, the tool may also be used as a rubric, where each item is scored on a scale of 1-4, with "4" being full credit.

1. Statement of Design Purpose/Problem:

_____ Statement of purpose is clear, concise, and understandable
_____ Intended problem is clearly testable
_____ Audience is appropriately addressed

2. Identification of Variable(s):

_____ Independent and dependent variable(s) are correctly identified
_____ A control method or design is established and designated for comparison
_____ Design and testing constants are identified

3. Materials and Procedure:

_____ All materials are listed in an organized manner
_____ Procedural steps are clear, logical (address intent of design), and communicate details at the proper level for the audience being addressed

4. Results Include Observations:

_____ Direct qualitative observations are described before, during and after the experiment
_____ Descriptions of qualitative observations include adequate detail
_____ Adequate amount of raw quantitative data is properly displayed
_____ Qualitative data is clearly organized in chart or tabular format
_____ Formulas, calculations, and statistics are appropriately displayed
_____ Data is illustrated using chart(s) or similar graphical formats that clearly and precisely displays trends and results

5. Data Analysis and Interpretation:

_____ Data is interpreted and discussed
_____ Relevant or unusual data collecting processes or occurrences are described
_____ Questions regarding precision or accuracy or results are addressed and discussed
_____ Modifications made to experimental design are communicated clearly, as well as analyses which led to consideration of redesign
_____ Clear and precise language is used in communicating analyses and interpretations

6. Conclusion:

_____ New understandings of relationship(s) between variables are clearly stated
_____ All statements are supported by the data, evidence, or by inference based on evidence
_____ Conclusion is written in a clear and concise manner

7. Recommendation(s) for Future Experimental Designs:

_____ Suggestions for design or procedural testing improvement or modifications are made based on results of past testing
_____ Recommendations for future design tests are written in a clear and concise manner

8. Safety:

_____ Number of safety infractions including proper clean up