

# **Lesson Plan: Problem Solving**

## **Concepts**

1. Using a standard method or procedure to solve problems makes the process easier and more effective.

## **Key Questions**

1. How do we apply a problem solving method to the solution of a real problem?
2. What are the steps of the Technological Method of Problem Solving?

## **Student Learning Objectives**

Students will demonstrate an understanding of the Technological Problem Solving method, and will be able to apply the method to a real life problem.

## **Educational Standards**

- NSES Science: A1.1, A1.6, E1.1-1.4, E2.1, E2.4, E2.6, E2.7, F5.3;
- ITEA Technology: 8, 9, 11

## **Anticipatory Set**

Scientists, engineers, and ordinary people use problem solving each day to work out solutions to various problems. Using a systematic procedure to solve a problem is efficient and easy. In this program, we use what is called “The Technological Method of Problem Solving.” This is a seven-step procedure that is highly iterative - you may go back and forth among the listed steps, and may not always follow them in order. Students will apply the Technological Method of Problem Solving to an in class example and to everyday problems.

Brainstorming about what we know about a problem or project and what we need to find out to move forward in a project is often a good starting point when faced with a new problem. This type of questioning provides a basis and relevance for the next couple of units that include energy science and technology.

In this unit, the general problem that is addressed is the fact that Americans use a lot of energy, with the consequences that we have a dwindling supply of fossil fuels, and we are emitting a lot of carbon dioxide and other air pollutants. The specific project that the students are assigned to address an aspect of this problem requires them to identify an action they can take in their own live to reduce their overall energy (or fossil fuel) consumption.

## Key Terms

Technological Method of Problem Solving
Brainstorm
Pros/Cons
Constraints

## Teaching Plan:

- Review
  - Talk about what you have been doing in the last week with the students. Ask “What did you learn from the game we played?”, “Do you think there is a world energy problem?”, and “If you said yes, could you describe it/What is it?”
- Introduce Technological Method of Problem Solving
  - Pass out Problem Solving Activity Sheets
  - Use an overhead or draw the Technological Method of Problem Solving (Problem Solving Spiral)
  - Go through the spiral step by step. Ask the students “What is a problem that you face everyday?” (What to wear?, What to get a friend for their birthday?, etc.) – see hints on the engineering problem solving description
  - Connect the steps to other methods that they are familiar with (ask the teacher what methods they have seen beforehand). The most common method they learn is the Scientific Method.
- Egg Demo
  - Have the students watch the demo. A detailed description of the demo is given in the Egg Demo Teacher’s Guide. This should be set up before class.
  - Tell the students that the goal is to get the 4 eggs into the glasses of water, without touching the glasses or eggs.
  - Go through the steps of the spiral and let the students brainstorm. Go through the pros and cons of each proposed idea.
  - Even though there is usually no “right” answer. The most easily implemented solution to this problem is to hit the tray in one swift movement. This will take the cards with it and allow gravity to move the eggs into the glasses.
- Energy Problem
  - Pass out selected Problem Statement (There is a very general form as well as a problem that is narrowed to the home)
  - Have a discussion as a class about how the problem solving method can be applied to our energy problem.
  - Discuss what we must learn in order to carry out this problem.

## Resources (included below)

Technological Method of Problem Solving description and spiral  
*Problem Solving Activity*  
Egg Demo Teacher's Guide  
Culminating Project Problem Statement (3 versions included)

## URL

All lesson plans in this unit are included at  
<http://www.clarkson.edu/highschool/k12/project/energysystems.html>

This URL has been included in the Engineering Pathways web site  
(<http://www.engineeringpathway.com/ep/index.jhtml>) and can be found with a search on  
“energy choices.”

## Owner

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## Contributors

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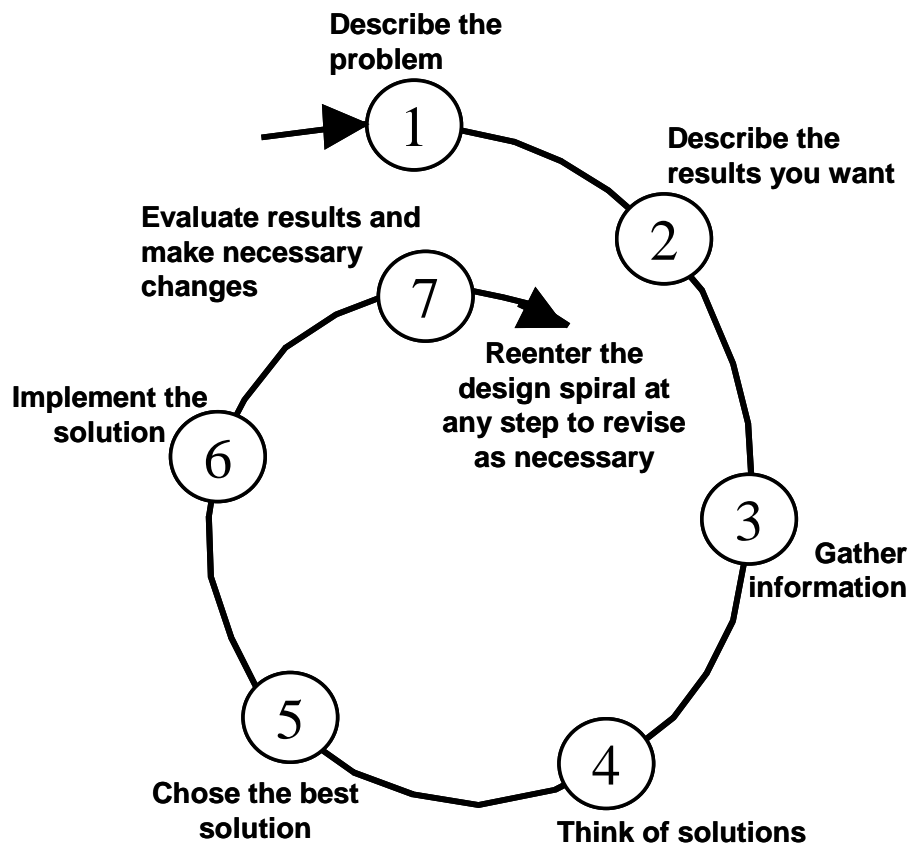
Version: December 2008

Figure 1:

# The Technological Method of Problem Solving

Solving a problem is faster, easier and has better results if you follow a procedure. But we must also remember that problem solving may require you to go back and forth between these steps, they are not always followed in order.

The procedure below shows the seven steps of the problem solving spiral. We will use these as we solve our problem.



Adapted from Hacker, M, Barden B., Living with Technology, 2<sup>nd</sup> edition. Delmar Publishers, Albany NY, 1993.

Table 1: The seven steps of problem solving

1. Identify the problem
  - ❖ Clearly state what the problem is.
    - ◆ Short, sweet and to the point
    - ◆ This is the “big picture” problem, not the specific project you’ve assigned
2. Establish what you want to achieve
  - ❖ Completion of a specific project that will help to solve the overall problem
  - ❖ In one sentence answer the following question:
    - ◆ How will I know I’ve completed this project?
  - ❖ List criteria and constraints
    - ◆ Criteria are things you want the solution to have
    - ◆ Constraints are limitations, sometimes called specifications, or restrictions that should be part of the solution. They could be the type of materials, the size or weight the solution must meet, the specific tools or machines you have available, time you have to complete the task and cost of construction or materials.
3. Gather Information
  - ❖ Research
    - ◆ Research sometimes needed both to better understand the problem itself as well as possible solutions
    - ◆ Don’t reinvent the wheel – looking at other solutions can lead to better solutions.
    - ◆ Use past experiences
4. Brainstorm possible solutions
  - ❖ List and/or sketch (as appropriate) as many solutions as you can think of
5. Choose the Best Solution
  - ❖ Evaluate solution by:
    - ◆ Comparing possible solution against constraints and criteria
    - ◆ Making trade-offs to identify “best”
6. Implement the solution
  - ❖ Develop plans that include (as required):
    - ◆ Drawings with measurements
    - ◆ Details of construction – Construction Procedure
  - ❖ Define tasks and resources necessary for implementation
  - ❖ Implement actual plan as appropriate for your particular project
7. Test and Evaluate the solution
  - ❖ Compare the solution against the criteria and constraints
  - ❖ Define how you might modify the solution for different or better results

Name: \_\_\_\_\_

## **Activity: Problem Solving**

### **Purpose:**

The first step in solving a problem is to understand what you want to accomplish. It is critical that you identify what you already know about the problem, as well as what you need to learn. In this activity we will apply the Technological Method of Problem Solving to an example problem.

### **Procedure**

1. Work in your group of 3-4 students.
2. Your teacher will present a problem to you. Write down what you want to accomplish and the constraints on the provided lines.
3. Identify what you know about the problem. This could be things you know from past experiences, classes, etc.
4. Identify what information you need to learn to solve the problem.
5. Brainstorm possible solutions.
6. Identify the pros and cons of each solution.
7. Make a choice based on the pros and cons.
8. Be prepared to share your ideas with the rest of the class.

# Understanding the Problem

What do we want to accomplish?

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What are the constraints?

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What do <i>we know</i> about this problem?	What do we <i>need to learn</i> to solve this problem?

What are <i>possible solutions</i> ?	<i>Pros</i>	<i>Cons</i>

Chosen Solution

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# Teacher's Guide: Egg Demo

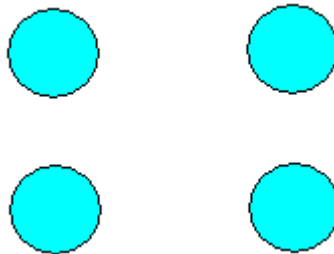
This demo can be used during the Problem Solving Activity as an interactive example of applying the method. The students brainstorm ideas and go through the PSM spiral while having fun.

## Materials

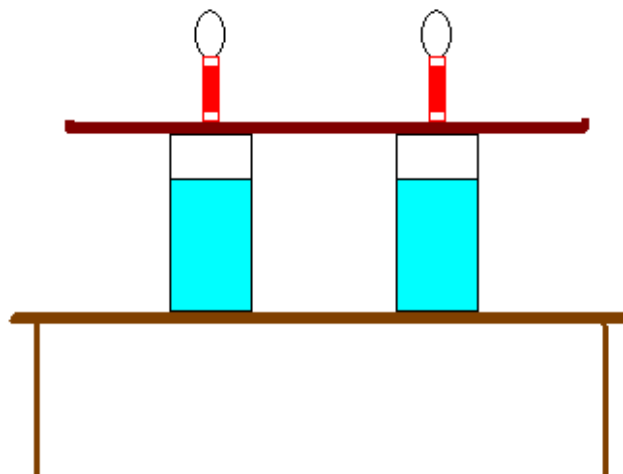
- 4 raw eggs
- 4 drinking glasses filled with water (It is preferable that the glasses have a wider top and do not taper). The glasses should be about  $\frac{3}{4}$  full.
- 4 rolled playing cards. Roll the cards so that the shorter sides are at the top and bottom and tape shut.
- 1 cafeteria-style tray

## Set-Up

- This should be done before class
- Place the four glasses in a square pattern as shown in the diagram below. Make sure the table they are placed on is level and does not roll.



- Place the cafeteria tray on top of the four glasses.
- Next, Place a rolled card directly above the center of each glass.
- Lastly, Place a raw egg, narrow end down, on top of each card.
- The final set-up should look like this from the side.





## **Problem Solving Brainstorm**

- This can be done either in groups or as a class.
- Tell the students the problem:
  - You want to get the eggs into the glasses without touching the eggs and glasses.
- Have the students identify the constraints and possible problems they face. (The eggs are unstable, the tray is in the way, etc)
- Go over what they know about the problem and what they need to learn. (They know that the eggs are directly above the glasses, they now that they can't touch the eggs or glasses but can touch the tray and cards, etc.)
- Have them brainstorm solutions. Go over the pros and cons of each solution and let them debate as a class. You will probably get a lot of ideas about balancing the eggs on the cards while you move the tray.
- Ultimately you want to lead them to the solution of hitting the tray out from under the eggs and cards.

## **Implementing the Solution**

- Hit the tray with one swift strong hit. The cards are light enough that they will fly off and the eggs should fall straight into the glasses.
- Discuss as a class why this worked.

Name \_\_\_\_\_

## Scenario

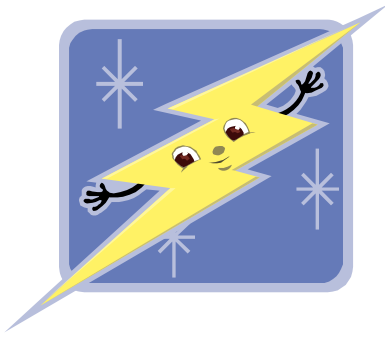
Energy is a huge part of our everyday life. In the United States alone we use nearly a million dollars worth each minute, 24 hours a day, every day of the year. That amounts to the energy that is in approximately seven gallons of gasoline a day for each person.



Our abundant use of energy and the energy choices we make each day affect our economy, environment, and society.

## Problem Statement

**Over the course of this energy unit, you will identify, defend and carry out a personal energy decision. This solution should positively affect your future and that of others.**



# Energy Project



## **Problem Statement:**

Energy is a huge part of our everyday life. In the United States alone we use nearly a million dollars worth each minute, 24 hours a day, every day of the year. That amounts to the energy that is in approximately seven gallons of gasoline a day for each person. Our abundant use of energy and the energy choices we make each day affect our economy, environment, and society.

**Identify, defend and carry out a personal energy decision that positively affects your future and that of others.**

## **Project Description:**

Students must make a choice concerning their daily practices that will reduce the amount of energy that is consumed in their practice. This must be clearly illustrated in a poster, including the choice made, types of energy conserved, approximate amount of energy conserved, and how they are going to implement their choice (including materials required to do so). Keep in mind all of the requirements of the project when making your choice, as well as what you have learned in class about energy and its uses. Students should strive to come up with ideas that are unique to their lifestyles and more in depth than just turning off the lights.

## **Project Requirements:**

There are four parts to this project:

1. Project Ideas Homework
2. Project Paragraph Homework
3. A poster or brochure that describes what choice you made to reduce the amount of energy that you use in your life.
4. A short presentation to the class on your energy saving decision.



## Problem Statement

Even as an individual person, you possess the power to change the future of the energy situation on our planet by making energy-conscious decisions in your home now as well as in your upcoming homes. Your goal for the semester is to research a way to limit the amount of fossil fuels used in your home and to communicate it to the rest of your class at the end of the program.