Research Experience for Teachers (RET) - Summer 2007

Lesson Module
A Step Towards Discovery:
Inquiry Skills in Science

Appropriate Subject Area(s):
Good to develop engineering skills and fosters critical thinking within a group. Therefore it would be useful in presenting the scientific method or engineering processes throughout any of the science content areas (7-10). This module would be most appropriate in a physical science curriculum. It would need to be amended for a higher level curriculum.

Rationale:
This is a representation of a rudimentary engineering problem. It will help students develop inquiry and problem solving skills. This activity also creates a cross-curricular connection between science and math.

Standard(s) & Indicator(s):
5.1.4.B1. Develop strategies and skills for information–gathering and problem-solving, using appropriate tools and technologies.

Learning Objective(s): Students will be able to:
- Apply the scientific method to reverse engineer a simple gadget.

Materials:
- Blue Books (to be used as engineering journals)
- Rulers
- Scales
- Mailing Tubes • Mailing Tube ends
- Circular binder rings • Rope
- Scissors
- Assorted of items not used in gadget. (these are meant to confuse students)

Approximate Time Required:
Two forty-minute periods. Time outside of class will be required.

List of Handouts:
- Lecture notes.
- Handout on Scientific Inquiry Process.
- Handout on Engineering Inquiry Process.

Background Information:
The teacher should give a brief discussion comparing the *Science Inquiry Process* (scientific method) with the *Engineering Design Process*. If applicable, review of the use of scales and measurement will be needed.

The “gadget” proposed is not used for any particular purpose.

Classroom Activity Description (Laboratory/Exercise/Problems):

- Brief lecture on the scientific inquiry process. This should include the steps involved in the scientific method (with accompanying notes). Comparison of the scientific inquiry process and the engineering inquiry process should be given now.
- After the introduction of the scientific method, place students into groups of two or three students.
- Each student should be given a bluebook to use as an engineering journal.
- Introduce the gadget to the students at this moment. Display the effects of pulling the ropes on the rope lengths at the corresponding corners. Explain that this gadget is a hypothetical apparatus found on a extra-terrestrial space craft. The objective for the students is to duplicate this Gadget.
- Provide a 10 min brainstorming session to manipulate and understand the gadget. Using their engineering journal, record the discussions of brainstorming activity. The student should also produce a drawing of their idea of what the Gadget is.
- Present students with a box with all the material to reproduce the gadget. Add other materials into opportunities to insure students are acquiring the right materials on their own.
- Have students replicate the gadget.
- It should have the following parameters.
  A. Tube needs to be same length.
  B. Same mass within +/- 3 grams.
  C. Ropes needs to be within +/- 2 cm.
- Have class time for students to present their models of the gadget and explain the logic behind their designs.

Homework/Exercises/Problems:

a) Collect all data on both mailing tube and rope. (Length, circumference)
b) Have students find the volume of the tube.

Assessment of Learning Outcomes:

- Engineering Journals (bluebooks) will be collected.
- Accuracy of the replica will be assessed.
- Rubric that takes into account a student’s ability for teamwork and a peer review of the replica.

The Black Box – Team Strategy

Date _____ Period_____

Team Members:_____

Introduction
Guessing what is contained in a Black Box is a classic problem of science. Many problems in science are solved by using the black box model to discover how something works or what it contains when you can't see inside, and the outside is not marked.

Problem: What's in the Box
Imagine you have a real black box, which contains some objects you want to identify.

1) Draw a flow plan using scientific method that helps you answer the question "what's in the box"
2) Make a list of questions with each step that you want to answer.

The "Black" Box

Name:_____ Date_____ Period_____

Using Scientific Method to Solve a Problem – use your strategy

1) Problem to Solve: What's in the box? Your box number _____

2) Following your strategy of questions and tests make a list of your observations on page 2. If you think of additional questions or tests for your box add them to strategy. USE COMPLETE SENTENCES.

3) Hypothesis: Make a list of what you think is in the box, and state why. Remember your hypothesis must explain observations!

Items in the Box:

_____

_____

_____

_____

_____

_____

4) Testing hypothesis: If you think some of the above items could be something else, write that here.

_____

_____

5) Show this list to the teacher for permission to open the box_____

List the ACTUAL contents of the box

_____

_____

_____

Grading of Lesson

Grading Catagories	0	1 - 2	3 -4	5	Total
"Blue Book" Journal	No Journal	Journal partially completed, major components missing.	Good journal practice followed but not complete.	Journal format extensive and complete.	
Replica	No Replica	Replica Attempted, major components materials left out.	Most of Replica complete, something left out	Replica accurately completed.	
Procedures for building "Gadget"	No procedures	Brief description given. Not enough detail given to accurately replicate experiment.	Strong description given, details left out.	Complete description of procedures that could be accurately duplicated.	
Conclusions & Analysis Questions	No Data or Conclusions	Present, but lacking in detail and accuracy.	Most data present, lacking graph or description.	Drawings, explanations and equations all present.	
				Total Points	

This material is based upon work supported by the National Science Foundation under Grant Nos. EEC-0552587 & EEC-0540855

Supporting Program: Center for Pre-College Programs, at the New Jersey Institute of Technology
Contributors
Robert Rolling (Emerson High School, Union City, NJ) Primary Author
Howard Kimmel, Levelle Burr-Alexander, John Carpinelli - Center for pre-College Programs, NJIT
Raj Dave - SOPS, NJIT