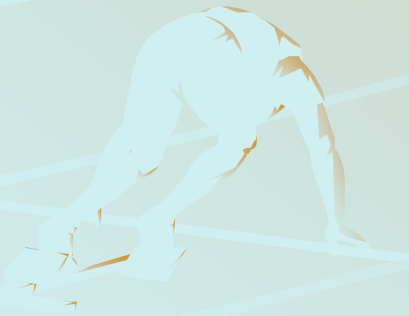


# **SCIENCE ACTIVITIES TO ENCOURAGE THINKING IN SCIENCE**

**Saouma BouJaoude  
Department of Education  
AUB**



# Activity 1

## THE CASE

- Someone has stolen the classroom digital camera! We received this ransom note this morning. I think this ransom note was written by a student in the class using one of the ink pens on the teacher's desk. How can we identify the student who possibly wrote the note?

If you want the  
classroom digital  
camera back, put \$250  
in an envelope and leave it  
under the big plant in the  
school lobby at 2:30.  
**COME ALONE AND LEAVE  
AS SOON AS YOU LEAVE  
THE MONEY**

# RANSOM NOTE

If you want the  
classroom digital  
camera back, put \$250  
in an envelope and leave it  
under the big plant in the  
school lobby at 2:30.

COME ALONE AND LEAVE  
AS SOON AS YOU LEAVE  
THE MONEY

## PROCEDURE

- ✦ Cut 1.5 cm by 13 cm strips of filter paper.
- ✦ Give each group of students 5 blank filter papers and one filter paper with a line 0.75 cm from the bottom written with the ransom note pen.
- ✦ Have the students make a line 0.75 cm from the bottom of each filter paper strip with one of the five suspect ink pens.
- ✦ Have them write the number of each ink pen at the top of the filter paper strip in pencil.

# PROCEDURE

- ✦ Place 1.5 cm of fingernail polish remover (acetone) in 6 different glasses for each group.
- ✦ Loop the filter paper strip over a pencil.
- ✦ Place the pencil over the top of the glass with the filter paper strip hanging down the center of the glass.
- ✦ Make sure the ink print end of the paper towel strip is toward the acetone. Have the end of the filter paper touch the acetone.
- ✦ Observe how the ink separates into different colors on the paper towel.
- ✦ Compare the chromatograms of the five suspect ink pens to the chromatogram of the ransom ink pen.
- ✦ Use the [ink pen chromatogram sheet](#) to record your findings.

# Ink Pen Chromatography Sheet

Place the chromatogram of each ink pen in the space below.

Ransom note	Ink pen #1	Ink pen #2	Ink pen #3	Ink pen #4	Ink pen #5

Which ink pen matches the ransom note chromatogram? \_\_\_\_\_

# WHAT IS CRITICAL THINKING?

- ✦ **Critical thinking is the process of evaluating propositions or hypotheses and making judgments about them on the basis of well-supported evidence.**





# CRITICAL THINKING VS CRITICISM

- ✦ **CRITICAL THINKING** does not mean to criticize in the sense of to find fault. Rather, critical thinking is an intellectual position from which to respond to ideas.
- ✦ **Critical thinking** requires rigorous interrogation of ideas and approaching ideas--new or familiar--openly yet skeptically.

[Critical thinking  
and science](#)



# CRITICAL THINKING VS CRITICISM

**In thinking critically, we**

- **Actively examine ideas**

- **Uncover assumptions**

- **Evaluate evidence**

- **Acknowledge and entertain alternative or opposing view points on the subject**

[Go to how many points are touching?](#)

# CHARACTERISTICS OF CRITICAL THINKING?

- ✦ Is focused in inquiry and is persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit (habitual curiosity).
- ✦ Contains an element of creativity as expressed through the generation of new options and new questions.
- ✦ Is an intellectual process - a mode of thinking - which can be learned and possibly must be learned.

# WHAT DOES CRITICAL THINKING REQUIRE?

- ✦ **Skillful use of data and information;** testing for validity and reliability of information are essential skills.
- ✦ **Open mindedness,** the desire to explore multiple options or explanations, and the willingness to reconsider assumptions and beliefs; accepts ambiguity and uncertainty.
- ✦ **Evidence-based judgment.**

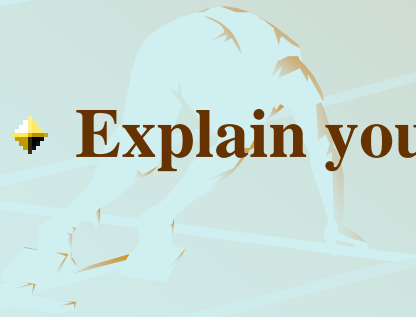
# WHAT DOES CRITICAL THINKING REQUIRE?

- ✚ **Clear and effective communications in formulating concepts, asking questions, and communicating with others to explore complex issues.**



## ACTIVITY 2

- ✚ Can you burn a dollar bill without destroying it!
- ✚ Observe the demonstration
- ✚ Explain your observation



## EXPLANATION

- ✚ A combustion reaction occurs between alcohol and oxygen, producing heat and light (energy) and carbon dioxide and water.



## EXPLANATION

- When the bill is soaked in an alcohol-water solution, the alcohol has a high vapor pressure and is mainly on the outside of the material. When the bill is lit, the alcohol is what actually burns. The temperature at which the alcohol burns is not high enough to evaporate the water, which has a high specific heat, so the bill remains wet and isn't able to catch fire on its own. After the alcohol has burned, the flame goes out, leaving a slightly damp dollar bill.



# RELATIONSHIP TO CRITICAL THINKING

- ✦ **What elements of critical thinking were used in solving the activity?**



# CRITICAL THINKING IN SCIENCE

- ✦ Scientific critical thinking implies more than generic critical thinking. Neither open mindedness nor common sense suffice.
- ✦ Crucial elements include familiarity with the nature of science, the experimental method and the accumulated wisdom of particular sciences.
- ✦ In addition to the following:
  1. Distinguishing correlation from cause and effect
  2. Distinguishing analysis from description
  3. Recognizing important variables in complex phenomena
  4. Isolating and testing variables
  5. Distinguishing scientific evidence, reasoning and rationalizing

# TEACHING METHOD

- ✚ What teaching method was used in the previous activity??



# PREDICT OBSERVE EXPLAIN (POE)

## *Step 1: Predict*

- Ask the learners to write independently their prediction of what will happen.
- Ask them what they think they will see and why they think this.

## *Step 2: Observe*

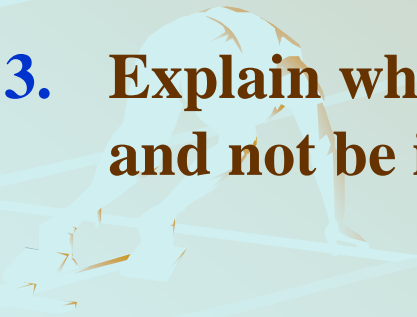
- Carry out the demonstration.
- Allow time to focus on observation.
- Ask learners to write down what they do observe.

## *Step 3: Explain*

- Ask learners to amend or add to their explanation to take account of the observation.
- After learners have committed their explanations to paper, discuss their ideas together.

# CHALLENGE

- 1. Can a person lie down on a bed of nails and not be injured?**
- 2. Write down your prediction**
- 3. Explain why or why not a person can lie on a bed of nails and not be injured**



## ACTIVITY 2

### OBSERVE






# EXPLAIN

- ✦ **The explanation of this phenomenon is related to the fact that the force per unit area of skin (i.e., pressure) is what determines if a nail will pierce the skin.**
- ✦ **The force is determined by the weight of the person lying on the bed of nails.**
- ✦ **The area is determined by the effective area of the tip of the nail, or nails, in contact with the skin.**
- ✦ **When a 'bed' of nails is used, the same force produced by the weight of the body is distributed over perhaps hundreds of nails. Therefore, the force applied to any one nail is correspondingly reduced, with the result that the force per unit area at the tip of any one nail will be below the level required to pierce the skin. Since this applies to all the nails in the bed, no nail then penetrates the skin.**



# RELATE TO CRITICAL THINKING

- What elements of critical thinking were encouraged through the previous activities? 
- What is the difference between using critical thinking and being critical?



# ACTIVITY 3: HOW MANY POINTS ARE TOUCHING?

- ✦ **What is your hypothesis?**
- ✦ **Design an experiment to test this hypothesis using the materials provided**



# TEACHING METHOD

- ✦ What teaching method was used?
- ✦ Was critical thinking encouraged?
- ✦ How?



# THE GENERAL INQUIRY MODEL

## 1. Identifying a question or problem

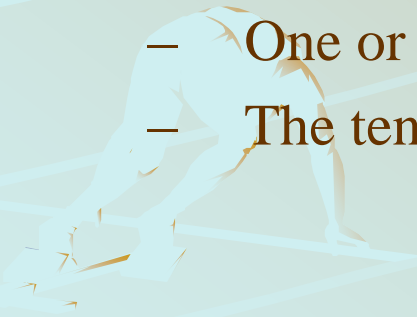
- The T, the Ss or both generate a problem
- The problem is genuine and relevant to Ss' interests and/or needs (or current/future content)
- The problem is discussed, clarified, and defined through discussion



# THE GENERAL INQUIRY MODEL

## 2. Forming hypotheses

- Ss suggest tentative solutions (hypotheses) to the problem
- Initially all hypotheses are accepted. Then the hypotheses are discussed and assessed for relevance and their verifiability with evidence
- One or a few hypotheses are selected for investigation
- The tentative nature of hypotheses is emphasized



# THE GENERAL INQUIRY MODEL

## 3. Gathering data

- Ss (whole class or S groups) identify relevant evidence and suggest plans to gather data
- Ss discuss and justify their plans and collect their data
- Ss discuss, organize and display their data
- The extent of T guidance depends on the learners' level of sophistication in conducting investigations



# THE GENERAL INQUIRY MODEL

## 4. Assessing hypotheses

- Ss discuss and analyze their data
- Ss assess the validity of their tentative hypotheses based on the collected evidence
- The logic of hypothesis testing is highlighted (prove/disprove vs. lend/detract support) and the value of hypotheses (even the ones rejected) in guiding investigations is emphasized.





# THE GENERAL INQUIRY MODEL


## 5. Generalizing

- Ss discuss whether and to what extent their conclusions can be generalized
- Valid generalizations are drawn



# HERRON SCALE: EVALUATING THE LEVEL OF INQUIRY

Level	Problem	Procedure	Solution
0	X	X	X
1	X	X	
2	X		
3			



An "x" indicates that students are provided with the information or steps necessary to complete the designated component

# RELATE TO CRITICAL THINKING

- **What elements of critical thinking were encouraged through the previous activities?**
- **Explain your answer**

