Introduction to Scientific Inquiry and Inquiry-Based Approaches

- **The formulation of a problem is more essential than a solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advances in science.**

Albert Einstein

- **People learn nothing unless they proceed from the known to the unknown.**

Claude Bernard

"Science is not a list of facts and principles to learn by rote; it is a way of looking at the world and asking questions."

F. James Rutherford

What's INQUIRY?

- **Scientific INQUIRY** refers to the diverse ways in which scientists study the natural world and proposed explanations based on the evidence derived from their work
- **INQUIRY** also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.

NRC, 2012

What is needed to do INQUIRY in the elementary and middle level classroom?

Abilities to do scientific INQUIRY

- Process skills needed to perform scientific investigations. For example:
  - ✓To design and conduct investigations
  - ✓To use tools and technology to gather data

Understandings about scientific INQUIRY

- Deeper insight of the nature of inquiry. For example:
  - ✓To use logical arguments based on evidence
  - ✓To use findings and discoveries as promoters of new ideas.

General Guidelines for Developing an Inquiry-based Lesson

1. Consider Student's Background
2. Create/describe the system of variables
3. Design an initial immersion experience
4. Generate researchable questions
5. Conduct the research
6. Design a consequential task
7. Assess understanding

Scientific Inquiry Model
Shulman & Keislar (1966)

Step 1 - Problem Sensing

Initial observations of the problem is taken.

A discrepant event or incongruity stimulates awareness of a problem.

Step 2 - Problem Formulation

Attempt is made to define or clarify the problem by questioning process.

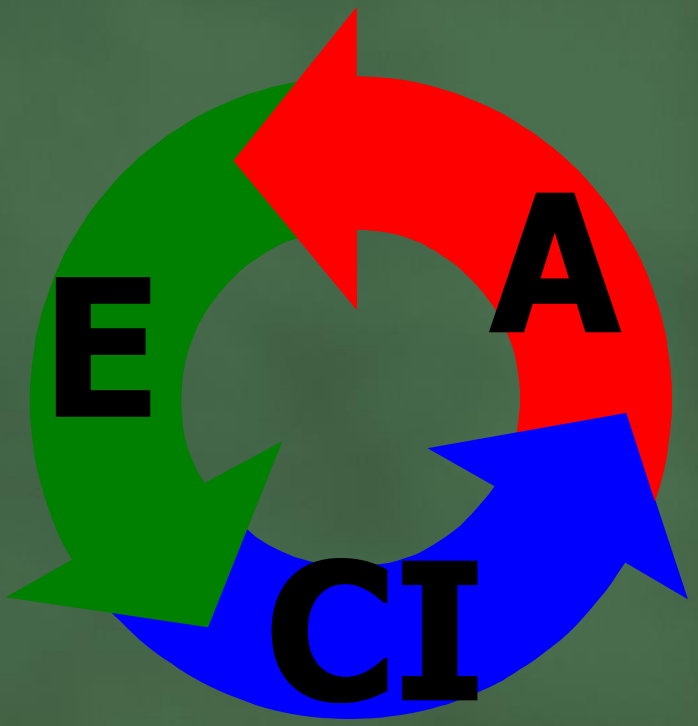
Step 3 - Searching

Questions about the problem are raised, information is gathered, hypotheses are formulated, and alternative solutions are explored.

Step 4 - Problem Resolving

The incongruity is removed to the satisfaction of the learner.

The Learning Cycle: A research-based alternative in inquiry science education – [SCIS]



What is the Learning Cycle?

- The **Learning Cycle** is an instructional approach designed to encourage self-regulation.
- It adapts teaching to three general phases based on constructivist instructional theories.
- The three phases of the Learning Cycle are:
  - **EXPLORATION**
  - **CONCEPT INTRODUCTION**
  - **APPLICATION**

EXPLORATION

- The EXPLORATION Phase should incorporate experiences that should raise questions that students cannot answer with their accustomed patterns of reasoning.
- Students should learn by acquiring information about new ideas and materials through their own actions and reactions.

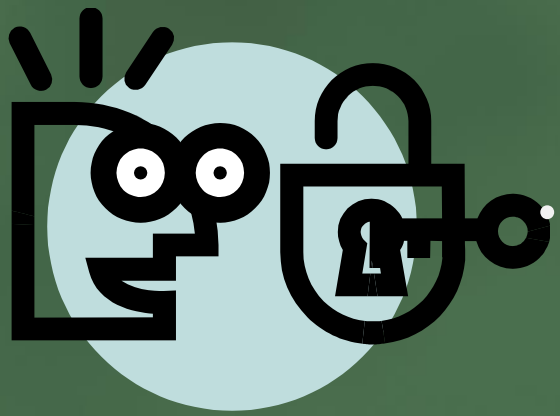
Between E & CI

- Before the CONCEPT is introduced to students, the teacher should help students define ideas in their own terms.
- Teachers can accomplish this task by summarizing and revising findings and writing conclusions about the EXPLORATION Phase.

CONCEPT INTRODUCTION

- Teacher presents the concept in a sophisticated and technical manner by using scientific terminology.
- The concept may be introduced by the teacher, the textbook, a film, or another method.
- Students should relate findings from EXPLORATION activity to the concept definition.

APPLICATION



- Students apply the new concept or reasoning pattern to new activities.
- This phase provides additional opportunities for self-regulation and the stabilizing of the reasoning pattern.
- APPLICATION activities are new, but similar, in most cases, to the EXPLORATION activities.

The LC & Cognitive Processes

- **EXPLORATION**
- **Disequilibrium**
- **CONCEPT INTRODUCTION**
- **Equilibration**
- **Accommodation**
- **APPLICATION**
- **Reinforcement and stabilization of new reasoning pattern**

The FERA Learning Cycle

Focus the Topic

- Asses prior knowledge & give students reason to explore

Explore

- Engage students in meaningful activities relevant to the content of lesson

Reflect

- Share findings & connect the experience to the content

Apply

- Use new knowledge & skills to solve new situation

•The 5-E Learning Cycle [BSCS]

Engage
- Create interest, assess prior knowledge

Explore
- Face situation, study characteristics & patterns

Explain
- Share findings and formally learn concepts

Elaborate
- Expand knowledge base to similar events

Evaluate
- Teacher & students assess participation, scientific process and learning outcomes

The true sign of intelligence is not knowledge, but imagination.

Albert Einstein