The Learning Cycle

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Workshop for new STEM Faculty

Inclusive Teaching Methods

The Scientific Method

The Learning Cycle

1. **Exploration**: observe phenomena, look for patterns

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2. **Term Introduction**: learn vocabulary to describe pattern

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1. **Exploration**: observe phenomena, look for patterns

2. **Term Introduction**: learn vocabulary to describe pattern

3. Application: use concept in new context (confirm idea or discover misconception)

Learning Cycle in Lecture

1. **Exploration**: Describe a piece of paper.

Learning Cycle in Lecture

2. **Term Introduction**:
Our description of paper is a list of **Properties**.

Physical Properties of a sample are observed by applying a force to it.

Chemical Properties of a sample are observed by doing a reaction that changes it into a new substance.

Learning Cycle in Lecture

3. **Application**:

List physical and chemical properties of paper.

Learning Cycle in Lecture

2. **Term Introduction**:

Properties that depend on the amount of paper are **Extrinsic Properties**.

Properties that do not depend on the amount of paper are **Intrinsic Properties**.

Learning Cycle in Lecture

3. **Application**:

What properties of paper are **Extrinsic**?

What properties of paper are **Intrinsic**?

Learning Cycle in Lecture

3. **Application**:

List the properties of water. Classify them as physical or chemical, extrinsic or intrinsic.

Traditional Organization

Start with technical terms and definitions,
Then give examples.

(Abstract to Concrete)

Advantage: lecture notes are very organized.

Traditional Organization

I. Adiabatic Processes.

A. Definition

Adiabatic: a process in which no heat is transferred.

$$q = 0$$

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Traditional Organization

I. Adiabatic Processes.

A. Definition

Adiabatic: a process in which no heat is transferred.

$$q = 0$$

B. Expansion of a gas against constant pressure.

Since $q = 0$, $C_V \Delta T = -p\Delta V$.

$$\Delta T = -p\Delta V / C_V < 0$$ since pressure, ΔV and C_V are positive.

That is why gases cool when expanded through a jet nozzle.

Learning Cycle in Lab

Students make observations, discover interesting trends.

Learning Cycle in Lab

Example: Measure mass and volume of samples made of different materials (wood, metal, glass).

From data calculate **Density** = mass / Volume.

Discover that density is a characteristic property of a material.

Constructivism

Learners try to fit new information into existing knowledge.

If new information can be connected to prior knowledge, it is more likely to be remembered.

Data for Acids

HA	Ka
HCl	10^{7}
H_2SO_4	10^{2}
H_2SO_3	1.5×10^{-2}
HF	3.5×10^{-4}
H_2S	9.1×10^{-8}

bond strengths (kJ/mol)	
N–H	391
O–H	467
F–H	565
P–H	320
S–H	323
Cl–H	427

Electronegativities		
H		
2.1		
N	O	F
3.0	3.5	4.0
P	S	Cl
2.1	2.5	3.0

CRITICAL THINKING QUESTIONS

Compare two binary acids with similar structures, H–O–H and H–S–H.

1. Which is a stronger acid, H_2O or H_2S?
2. Which polar bond has a greater positive charge on the hydrogen, O–H or S–H?
3. Which bond is easier to break, O–H or S–H?
4. What aspects of molecular structure correlate with high acidity in binary acids?

Further Steps in Cycle

Application: Students check hypothesis to see if it works with other binary acids.

Cycle back to consider acids with more complex structures.
Do they fit the same patterns?
Are the same factors responsible for their relative strengths?

POGIL Method

Process-Oriented Guided Inquiry Learning

Initiated at Franklin & Marshall College,
expanded through several NSF grants

Small group activities with Learning Cycle structure

Student-centered, cooperative learning

Opportunities to be creative

The Learning Cycle in Music

1. Experience

2. Explanation

3. Extrapolation