SCIENCE CONCEPTS AND GENERIC SCIENCE SKILLS RELATIONSHIP IN THE 21ST CENTURY SCIENCE EDUCATION

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WHAT KIND OF SCIENCE EDUCATION?

- SCIENCE CONTENT EXPLANATION
- SCIENCE CONCEPTS ROTE LEARNING
- COOK-BOOK EXPERIMENTS
- VERIFICATION EXPERIMENS
- TEACHER CENTERED SCIENCE TEACHING

A NEW PARADIGM OF SCIENCE EDUCATION

- PROVIDING STUDENTS WITH EXPERIENCES THAT ENABLE THEM UNDERSTANDING SCIENCE
- GUIDING STUDENTS TOWARD UNDERSTANDING SCIENCE
- ENABLING STUDENTS TO USE THEIR SCIENCE KNOWLEDGE

CHANGING THE MODES OF LEARNING SCIENCE

- LEARNING SCIENCE THROUGH THINKING SCIENCE
- LEARNING SCIENCE THROUGH EXPERIENCING SCIENCE
- LEARNING SCIENCE TO DEVELOP GENERIC SCIENCE SKILLS

SCIENTIFIC THINKING FRAMEWORK (1)

- THE UNIVERSE IS A SINGLE SYSTEM IN WHICH THE BASIC RULES ARE EVERYWHERE THE SAME
- SCIENCE IS A PROCESS FOR PRODUCING KNOWLEDGE
- CHARACTERISTIC OF SCIENCE ARE TENTATIVENESS OF CONTINUITY, STABILITY AND CHANGE

SCIENTIFIC THINKING FRAMEWORK (2)

- SCIENCE IS ONLY AN APPROACH TO AN “ABSOLUTE” CONDITION
- SCIENCE IS NOT VALUE FREE
- SCIENCE IS LIMITED THAT CANNOT DECIDE GOOD OR EVIL

UNITY OF SCIENCE DISCIPLINES (COMMON THEMES)

- SYSTEMS
- MODELS
- CONSTANCY
- PATTERN OF CHANGE
- SCALE
- EVOLUTION

GENERIC SCIENCE SKILLS

- DIRECT AND INDIRECT OBSERVATION
- SENSE OF SCALE
- SYMBOLIC LANGUAGE
- LOGICAL SELF-CONSISTENCY OF NATURAL LAWS
- LOGICAL INFERENCE
- CAUSALITY
- MATHEMATICS MODELLING
- CONCEPT FORMATION

SCIENCE DISCIPLINES, GENERIC SCIENCE SKILLS AND SCIENTIFIC TOPICS RELATIONSHIP (1)

- **SIENCE DISCIPLINE:** PHYSICS
- **TOPICS :** THERMODYNAMICS, AND MAGNETICS INDUCTION
- **GENERIC SCIENCE SKILLS :**

  INDIRECT OBSERVATION, MATHEMATICS MODELLING, SYMBOLIC LANGUAGE, CAUSALITY, LOGICAL SELF-CONSISTENCY OF NATURAL LAWS, CONCEPT FORMATION

SCIENCE DISCIPLINES, GENERIC SCIENCE SKILLS AND SCIENTIFIC TOPICS RELATIONSHIP (2)

- **SIENCE DISCIPLINE:** BIOLOGY
- **TOPICS :** BACTERIOLOGY & VIROLOGY, DIFFERENCIATION OF LIFE ORGANIZATION, METABOLISM & GENETICS PRINCIPLES
- **GENERIC SCIENCE SKILLS :**

  INDIRECT OBSERVATION, MATHEMATICAL MODELLING, SYMBOLIC LANGUAGE, CAUSALITY, LOGICAL SELF-CONSISTENCY OF NATURAL LAWS, CONCEPT FORMATION, LOGICAL INFERENCE, SENSE OF SCALE

SCIENCE DISCIPLINES, GENERIC SCIENCE SKILLS AND SCIENTIFIC TOPICS RELATIONSHIP (3)

- **SIENCE DISCIPLINE:** CHEMISTRY
- **TOPICS :** HYDROLISIS, COLLIGATIVE PROPERTIES, IDEAL GAS CHANGE
- **GENERIC SCIENCE SKILLS :**

  DIRECT & INDIRECT OBSERVATION, MATHEMATICAL MODELLING, SYMBOLIC LANGUAGE, CAUSALITY, LOGICAL SELF-CONSISTENCY OF NATURAL LAWS, CONCEPT FORMATION, LOGICAL INFERENCE, SENSE OF SCALE

THE SPECIFICITY OF GENERIC SCIENCE SKILLS AMONG SCIENCE DISCIPLINES

- PHYSICS AND CHEMISTRY :LOGICAL SELF-CONSISTENCY OF NATURAL LAWS AND CAUSALITY
- BIOLOGY : SENSE OF SCALE

THE RELATIONSHIP OF GENERIC SCIENCE SKILLS AND KIND OF CONCEPTS

- DIRECT OBSERVATION: CONCRETE CONCEPTS
- INDIRECT OBSERVATION: ABSTRACT CONCEPTS
- LOGICAL INFERENCE, CAUSALITY: CONCEPTS WHICH REQUIRE KNOWLEDGE OF PRINCIPLES
- LOGICAL SELF-CONSISTENCY OF NATURAL LAWS: ABSTRACT CONCEPTS, CONCEPTS WITH CRITICAL ATRIBUTE THAT ARE NOT PERCEPTIBLE BUT HAVE PERCEPTIBLE INSTANCES, CONCEPTS THAT NAME PROCESSES, ATTRIBUTE AND PROPERTIES
- MATHEMATICAL MODELLING, SYMBOLIC LANGUAGE: CONCEPTS INVOLVING SYMBOLIC REPRESENTATIONS

SCIENCE CONCEPTS' CHARACTERISTICS

- ***PHYSICS AND CHEMISTRY* :** ABSTRACT CONCEPTS, CONCEPTS WITH CRITICAL ATRIBUTE THAT ARE NOT PERCEPTIBLE BUT HAVE PERCEPTIBLE INSTANCES, CONCEPTS THAT NAME PROCESSES, ATTRIBUTE AND PROPERTIES, CONCEPTS WHICH REQUIRE KNOWLEDGE OF PRINCIPLES
- ***BIOLOGY :*** ABSTRACT CONCEPTS, CONCEPTS WITH CRITICAL ATRIBUTE THAT ARE NOT PERCEPTIBLE BUT HAVE PERCEPTIBLE INSTANCES

THINKING THROUGH SCIENCE

- GENERIC SCIENCE AS STUDENTS' COMPETENCE ON SCIENCE
- GENERIC SCIENCE SKILLS AS THINKING SCIENCE
- LEARNING SCIENCE FOR DEVELOPING HIGHER ORDER THINKING SKILLS