Science as a process of inquiry

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Expert Evaluators Comments (May 2010)

- There is a need for greater theoretical coherence to underpin both the development work and also the case studies book
- There is a need to delineate the contribution of each partner with respect to curriculum, teaching, learning and assessment as aspects of inquiry-oriented science education

What is Science?

- Science is a social process of developing reliable knowledge
- Science seeks to develop an understanding of phenomena and how systems function
- Science relies largely on investigation methods

What is Technology?

- Technology is a social process of responding to human needs
- Technology seeks to develop solutions to human /social problems
- Technology relies broadly on design and innovation methods

Research Informed (Constructivist) Curricula: Nuffield Primary Science Course

Activity based science curriculum Programs: *ESS, SCIS, SARA,* PSSC Physics, Project Physics, Nuffield Physics Course

Computer enhanced curricula Networked learning

Textbooks-recompiled expositions of established knowledge

Prehistory 1950 1960 1970 1990

1956 Sputnik

1980 National Assessment Exercises (UK, US)

1996 TIMSS

2000 PISA

Misconceptions Research

Science teaching research

Science learning research

A long history of recycling ideas on active learning, collaborative learning, hands on approaches... (G. De Boer, A history of Science Education, 1996)

Progression of paradigms in Science Teaching

- Knowledge Transmission - Content delivery model
- Discovery Learning (Activity based science)
- Knowledge Construction (Minds on)
- Inquiry oriented teaching and learning (Authenticity)

Scientific Inquiry
(NRC 2000)

Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose 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.

Scientific Inquiry
(S-TEAM STAN)

Inquiry-based science teaching and education engages students in:

(i) authentic, **problem-based** learning activities where there may not be a correct answer

(ii) experimental procedures, experiments and "**hands on**" activities, including searching for information

(iii) self-regulated learning sequences where **student autonomy** is emphasised

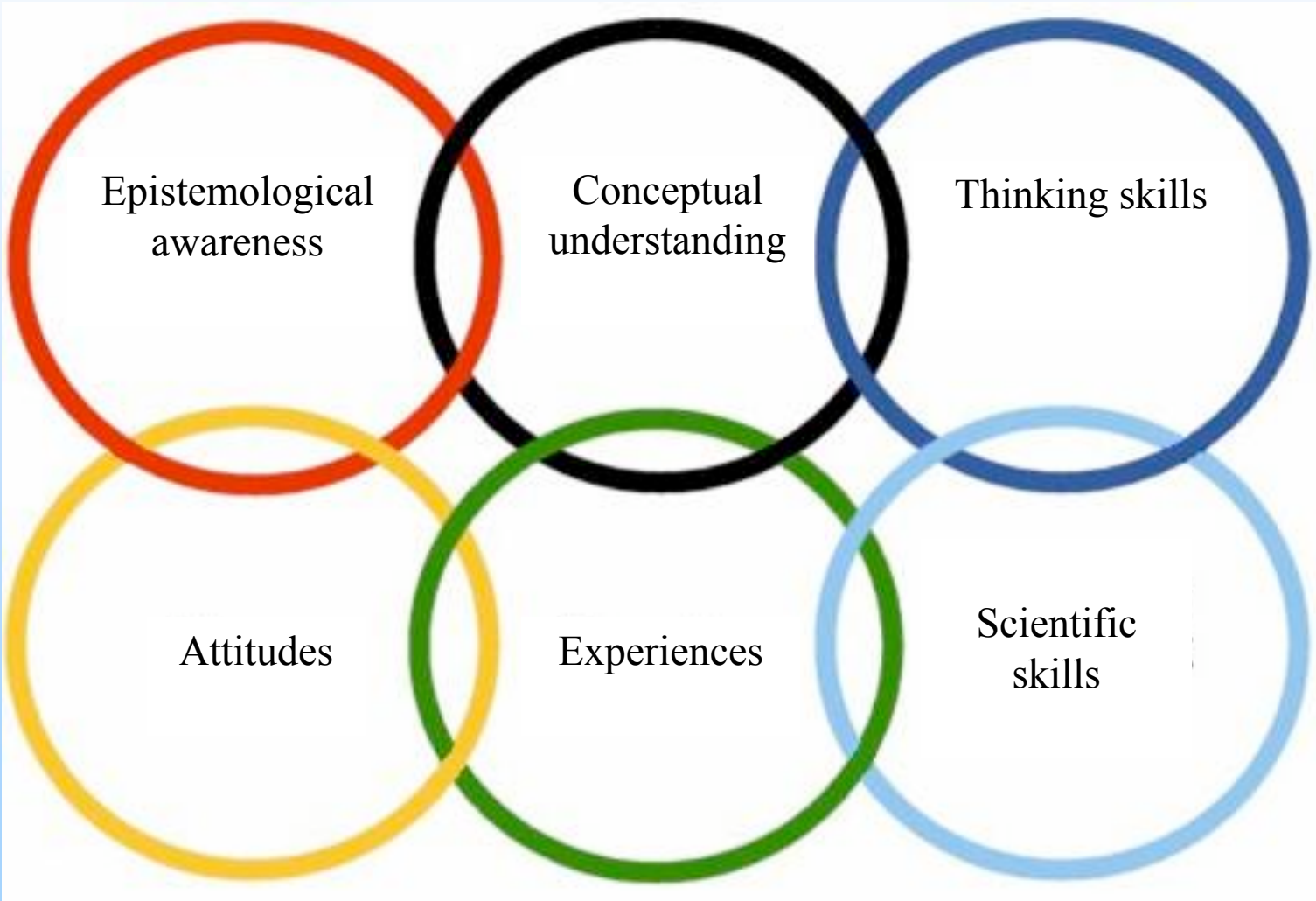
(iv) discursive **argumentation** and communication with peers ("talking science")

Inquiry-based learning

A framework for science teaching and learning

- Learning
  - active engagement of students in the learning process
  - epistemologically authentic procedures
  - social interaction and collaboration
  - holistic learning objectives
  - coherent interpretive frameworks as important epistemic products
- Learning environments
  - designed to promote construction of meaning and gradual development of skills and awareness
  - assessment has a formative role in providing feedback to the teaching and learning process

Integrated Learning Goals



Inquiry-based learning

A framework for science teaching and learning

- Teaching
  - the teacher adopts the role of a facilitator and aims to provide an example of an inquiring person
  - the teacher does not function, in the eyes of the students, as the sole bearer of expert knowledge
  - motivation: there are structured procedures for the emotional engagement of students in the learning process
- Curriculum Materials
  - function as a means to guide the learning process
  - designed and validated through a process of research

A Methodology for designing teaching and learning materials

Formulation of Integrated Learning Objectives

Epistemological Analysis
Conceptual and Reasoning Prerequisites

Teaching Learning Strategy

Selection of Tools Analysis of Capabilities

Research into students' difficulties and initial ideas

Design Learning Activity Sequences

Classroom Evaluation and Research

Curriculum Materials for Inquiry-Based Learning

- Curriculum materials serve as a resource for teachers which can be used effectively only after adequate preparation and training
- Teaching is guided by a sequence of activities, without lecture and without «content delivery», «extensive explanations» or «theoretical expositions»
- Learning is proceeds partly through investigative action
- Emphasis is placed on active student engagement with the learning process, collaborative interaction and constant re-negotiation of ideas on the basis of data, observations or theories
- Teaching is limited to the facilitation and progression of student learning. It often takes the form of semi-socratic dialogue and critical discourse and only more rarely does it include explanation or exposition of ideas from an expert.
- The reasoning and argumentation are more often inductive and less commonly (and usually later) deductive

  Activity sequences are developed, evaluated and refined through an iterative process of research in actual classroom environments

Inquiry-based learning: variations

- Degree of structure
  - Open inquiry - guided inquiry
- Degree of emphasis on reflection and interpretation of reflective strategies
  - Planning, monitoring and evaluation
  - Metacognitive strategies: abstraction, generalization
- Degree of ICT involvement
  - Simulations, modeling tools, sensors, data analysis tools
  - Communication tools

Inquiry: a teaching and learning framework with the following attributes

- Active student engagement in a process of developing meaning
- The learning pathway is guided by a sequence of activities that was designed and validated through a research process
- In the design of the activity sequence, an effort is made to induce a sense of authenticity with respect to the knowledge domain:
  - The topic is likely to be of interest to most students
  - The learning objectives are consistent with the complexity of the nature of science and might include: experiences and concepts, methodological processes, aspects of epistemological awareness, reasoning strategies
  - Student interest is enhanced through activities designed to promote positive attitudes to science
  - The activity sequence is developed with a purpose to bridge the exiiting gap between school science and authentic scientific procedures
  - Reflective scaffolding is used to guide student thinking
- Assessment is primarily formative in character

For Case Studies Book

Key issues

- Supporting teachers in the context of evolving school and educational systems: contextualized innovation and the need for adoption of T-L frameworks as scaffolds for managing the learning process
- Tools for supporting teachers: curriculum-TLS, teaching models, learning indicators, formative assessment, partnerships and reflective collaboration

- There is a need to situate each partner's work within these issues

Science and art belong to the whole world, and before them vanish the barriers of nationality

Johanne Wolfgang Goethe
1813

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