

Honouring the Privilege of Being a Science Author

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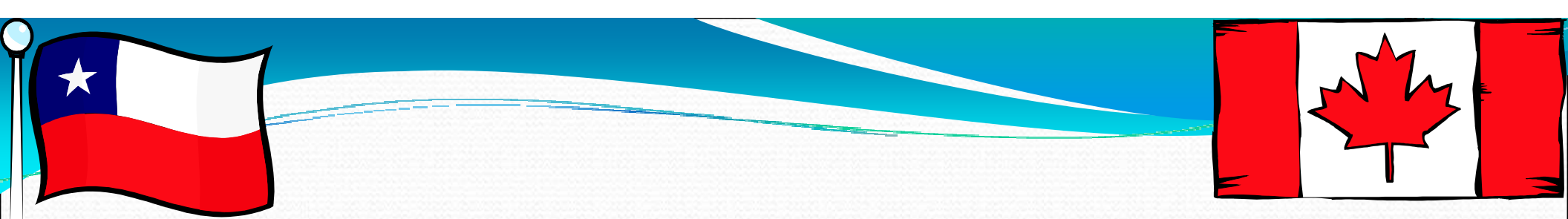
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Edmonton, Canada



My apologies

- Buenas Tardes,
- Mis disculpas que no he apredido suficiente Espanol para poder conversar con Ustedes hoy dia. Mi familia ha decidido que vamos a tratar de aprender a leer, escribir y a hablar un poquito de Espanol. La proxima vez yo estare mejor preparado.
- Good afternoon,
I apologize that I have not learned enough Spanish to at least try to speak to you today. My family has decided that we are going to make an effort to learn to read, write and speak some Spanish. Maybe next time I will be better prepared.



Chilean Connections to Canada

IANAS leaders **Jorge Allende**, **Rosa Deves** and many others have welcomed Patricia Rowell and myself into IANAS and we in turn have welcomed delegations and teachers to the UofA in Edmonton.

Eugenio Ortega, Chilean Ambassador to Canada for Her Excellency Michelle Bachelet, Ottawa, May 2010

- *“We both want a more humane world that respects the environment and seeks prosperity, justice, social protection and equality. ... We are partner countries with a view to the future.”*



My Journey of Learning

- an **undergraduate education student** for 4 years
- a high school chemistry & physics **teacher** for 32 years
- a **graduate student** while teaching (an MEd and PhD)
- a chemistry **teacher-author** in Canada for 35 years
- a **university instructor** in education for 5 years
- a **co-director** of the Centre for Mathematics Science and Technology Education (**CMASTE.ca**) for 6 years
- a **co-director** of the Centre for Research in Youth Science Teaching and Learning (**CRYSTALAlberta.ca**)
- a **father** of 2, a **grandfather** of 3, and **husband** of 1

Author Perspectives

- Technical perspectives
- Pedagogic perspectives
- Curriculum perspectives
- Nature of science perspectives
- Textbook language perspectives
- Laboratory work perspectives
- Laboratory report perspectives
- Knowledge perspectives
- Inquiry for citizenship perspectives





Technical perspectives

- font size & style
 - **SI** (international) metric
 - ten metres and 10 m
 - **IUPAC** nomenclature
 - 2-propene or prop-2-ene
 - **certainty & precision**
 - significant digits
 - **active voice; present tense**
- include **lab work** in the **text** or not (and how?)
 - use a **daily-lesson** segmentation
 - text, example, exercise
 - pre-lab, lab, post-lab
 - marginalia; photos & art, including **diversity**
 - **editing rules** are up front for the authors



Pedagogy-as-Science Perspectives

- **concrete to abstract**
 - empirical to theoretical
- **constructivist approach**
 - evaluating your own claims to knowledge
- **“Watch your language.”**
 - use NoS language
- **question & answer**
 - essential to inquiry
- **discussion approach**
 - teamwork in science
- **brainstorming approach**
 - logical tests of ideas
- **collaborative learning**
 - laboratory teamwork
- **problem-based learning**
 - essential to inquiry
- **inquiry-based learning**



Curriculum Perspectives

The “four pillars”

- **concepts** (knowledge)
 - and subconcepts
- **processes** (skills)
 - Don't aim low.
- (scientific) **attitudes**
 - Don't aim low.
- **STSE issues**
 - perspectives, pro & con
 - decision making model

Additional pillars

- aboriginal science
- (ICT) information & communication technology

Some pillars are more equal than other pillars. Some are for show and some are for function—depending on curricular values.

Curriculum Emphases

(Companion Meanings by Douglas Roberts)



Curriculum emphases

Restricted from full STSE curriculum emphases to:

- nature of science (NoS)
- science & technology interaction
- STSE issues

Companion meanings

Converting contexts to content (concepts) of

- nature of science (NoS)
- science & technology interaction
- STSE issues

What kinds of knowledge do we value? What bias do we hold for pure science knowledge? What kinds of knowledge are used only as context for learning, rather than content for learning?

Nature of Science Perspectives



- **create** a concept
 - inductive reasoning
- **test & verify** hypothesis
 - hypothetico-inductive
- **test & verify** prediction
 - hypothetico-deductive
- **use** a concept
 - deductive reasoning
- **test & falsify** an hypothesis or prediction

- The **scientific purposes** of laboratory work are classified as C, T or U.
- $C \rightarrow T \rightarrow U$ is a **progression** for a concept—an increase in **certainty** /validity/trust.
- $C \rightarrow T \rightarrow U \rightarrow T$ eventually leads to **falsification** of hypotheses or predictions.



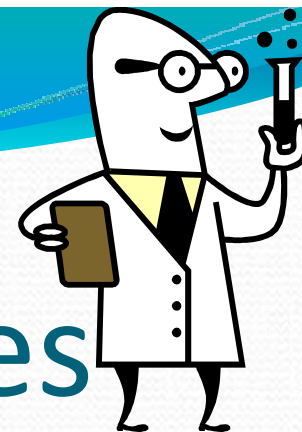
Language Perspectives

Watch your language!

- Based upon the **evidence** gathering here,
- According to the **Bohr model** of the atom,
- The evidence suggests a **correlation** between
- The prestigious **journal**, *Science*, reports that

- Only using three **samples** we found that...
- The **reliability** was high among the class members but
- The **certainty** expressed in significant digits is

Write like a scientist writing for a peer-reviewed journal. Use nature of science language.



Laboratory Work Perspectives

Nature of Science

Problem Solving

Processes

Skills

- Knowledge, skills and attitudes (KSAs) need (for the future) to be reinvented as **concepts**, **problem solving (or processes)**, and **scientific attitudes**—all guided by a modern view of the nature(s) of science.

Natures of Science Umbrella



Nature of Science

Problem Solving

Processes

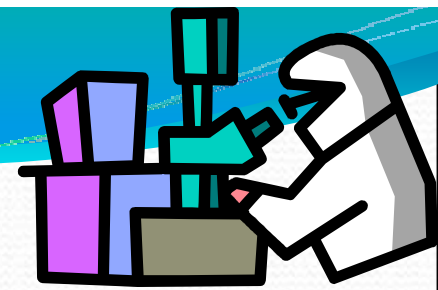
Skills

C-I: create inductively
T-HI: test hypothesis
T-HD: test prediction
U-D: use deductively

Lab Report: Processes



Purpose	Create (I)	Test (H-I)	Test (H-D)	Use (D)
Problem	general	general	specific	specific
Hypothesis	X	general	general	X
Prediction	X	X	specific	X
Analysis	general	general	specific	specific
Eval. 1	evidence	evidence	evidence	evidence
Eval. 2	X	hypothesis	prediction hypothesis	X



Laboratory Report Perspectives

Scientific purposes

- The scientific purpose (e.g., create, test or use) **drives the type of processes involved** in laboratory work and laboratory reporting.
- Decide on the scientific purpose **first** and use the previous table for help.

Scientific method(s)

- The model presented here has **four scientific methods**—C,TH,TP,U.
- A laboratory report is **not the scientific method**—it is just a report that idealizes the method—which is much more dynamic.



Ten Evidential Bases (and more)

Ways to present evidence

- thought experiments
- demonstrations
- dry lab (lab exercise)
- wet lab (in a laboratory)
- field trip

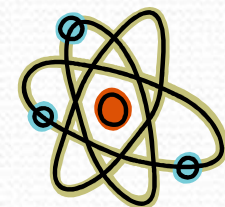
Computer based ways:

- computer probes
- video/photo lab
- computer video-analysis
- simulation/animation
- remote access

There are **no excuses** for not including evidence-based reasoning in the science classrooms, in the science textbooks, and in the assessment tools. All of these evidential bases **provide opportunities for assessment.**

Lab Unit Plan: CTU & Evid.Bases

Evidential Bases	Test (HorP) (falsify)	Create (I)	Test(HorP) (verify)	Use (D)
thought experiment			Inv. 10.3	
demonstrations				Inv. 10.6
dry lab (lab exercise)		Inv. 10.2		
wet lab (in a laboratory)	Inv. 10.1			
field trip				
computer probes			Inv. 10.4	
video/photo lab			Inv. 10.5	
computer video-analysis				
simulation/animation				Inv. 10.7
remote access				



Knowledge Perspectives

- **empirical knowledge**

- observable
- empirical definitions , empirical hypotheses, generalizations, and laws

- **concrete knowledge**

- reacting masses
- boiling points
- litmus tests

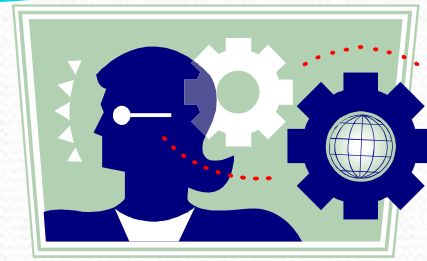
- **theoretical knowledge**

- not observable
- theoretical definitions, theoretical hypotheses, models, and theories

- **abstract knowledge**

- atomic theory
- chemical bonding
- acid-base theories

Scientific Attitudes



Scientific attitudes are **predispositions to act** in a certain (scientific) way.

Scientific attitudes have been described as “**that which is left** after all else has been forgotten”.

Scientific attitudes may be among the ultimate goals for science education.

Scientific Attitudes:

- critical mindedness
- suspended judgment
- respect for evidence
- honesty
- objectivity
- willingness to change
- open-mindedness
- questioning attitudes

Inquiry Concepts for Citizenship



--evaluating claims to knowledge

- anecdotal evidence?
- correlational study?
- cause & effect study?
- clinical trial?
- placebo & placebo effect?
- double blind design?
- sample size?
- random sample?
- term of study?
- controls & control group?
- peer-reviewed (refereed)?
- prestigious journal?
- funding agency?
- replication needed?
- expressed (un)certainty?
- scientific attitude(s)?
- multi-perspective view, pro and con?

Gracias

- Centre for Advance Research in Education
- Mathematical Modelling Centre
- Chilean Ministry of Education
- *Jorge Allende, Rosa Deves, Eugenia Diaz, Milton de la Fuente, Isabel Ramos Moore, Paola Pacheco, et al.*



Acknowledgements:

- my fellow authors
- www.CMASTE.ca under Outreach
- www.CRYSTALAlberta.ca under Resources and Science Reasoning Text
- IANAS and ECBI/IBSE
- my students
- my family