Developing Students Into Scientists Through Content-Knowledge, Reflection, and Expression

Matthew A. Lynn, Ph.D.
Vietnam Teacher Education Institute
PEN International / National Technical Institute for the Deaf

Transforming students into scientists requires them:

To know facts

and (more importantly)

To be able to understand
and to use these facts

Relevance, accessibility, and **engagement** are important keys to teaching **any** student.

My goal today is to teach you some organic chemistry and to show you the instructional methods in these three areas that have been the most successful for me.

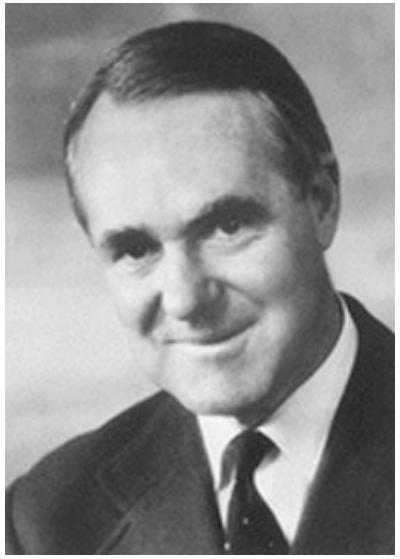
So, who is Matt?

B.S. in chemistry (Ohio State)
M.S. in chemistry (Indiana University)
Ph.D. in chemistry (University of Arizona)

My graduate work was in the area of
physical inorganic chemistry.

I had no experience teaching deaf and hard-of-hearing students before I came to NTID, but I had been taking ASL classes.

John Cornforth
Nobel Prize Winner - Deaf Chemist



Cornforth won the 1975 Nobel Prize in Chemistry for his work to understand the stereochemistry of enzyme-catalyzed reactions.

What Do I Do Here?

Tutor NTID-supported students in any College of Science chemistry class

Teach NTID chemistry classes

Advise NTID-supported chemistry majors in the College of Science

Teaching Philosophy

To educate deaf and hard-of-hearing students not only about the science of chemistry and its applications, but also about their roles as scientists in the world-at-large.

Methods

Direct instruction, via lecture and laboratory activities, as well as writing exercises and in-class discussions.

Rationale

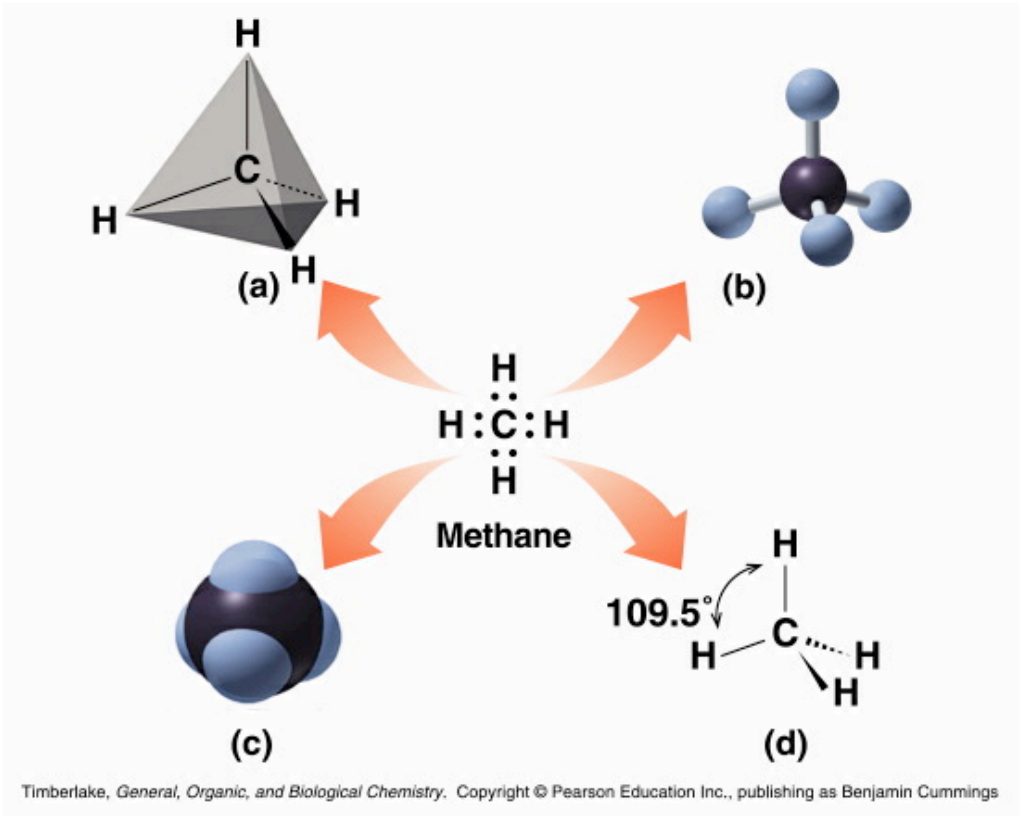
I remember much of my post-secondary education being heavy on facts and light on understanding how it related to "everyday" science.

Alkanes

Step One: The Facts

Tetrahedral Structure of Carbon

A carbon atom always has four bonds.



Definition

An **alkane** is a hydrocarbon that contains only carbon-carbon single bonds.

The general formula for an alkane is

$$\mathbf{C_nH_{2n+2}}$$

In-Class Problem 1

IUPAC Nomenclature System

IUPAC means

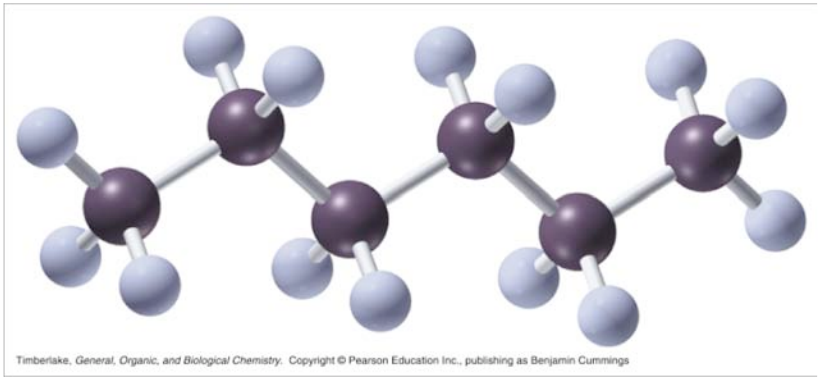
"International Union of Pure and Applied Chemistry"

::

No. of C atoms	Prefix	Name	Molecular Formula	Condensed Structural Formula
1	meth-	methane	CH_4	CH_4
2	eth-	ethane	C_2H_6	CH_3CH_3
3	prop-	propane	C_3H_8	$CH_3CH_2CH_3$
4	but-	butane	C_4H_{10}	$CH_3CH_2CH_2CH_3$
5	pent-	pentane	C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$
6	**hex-**	**hexane**	**C_6H_{14}**	**$CH_3CH_2CH_2CH_2CH_2CH_3$**
7	hept-	heptane	C_7H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
8	oct-	octane	C_8H_{18}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
9	non-	nonane	C_9H_{20}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
10	dec-	decane	$C_{10}H_{22}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

Line-Bond Formulas

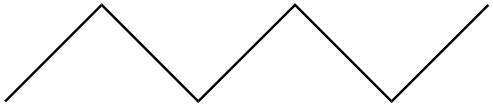
Chemists use line-bond formulas to draw molecules quickly.



ball-and-stick drawing

$CH_3CH_2CH_2CH_2CH_2CH_3$

condensed
structural formula



line-bond formula

These are three ways to depict hexane.

In-Class Problems 2 and 3

Molecules that have the same formula but different connectivity of atoms are called **constitutional isomers**.

Molecules that are constitutional isomers of each other have different names.

Activity

Use the model kits to construct constitutional isomers of alkanes that have the formula C_6H_{14}.

Physical Properties of Alkanes and Cycloalkanes

Solubility and Density

Nonpolar

✾not soluble in water

Less dense than water

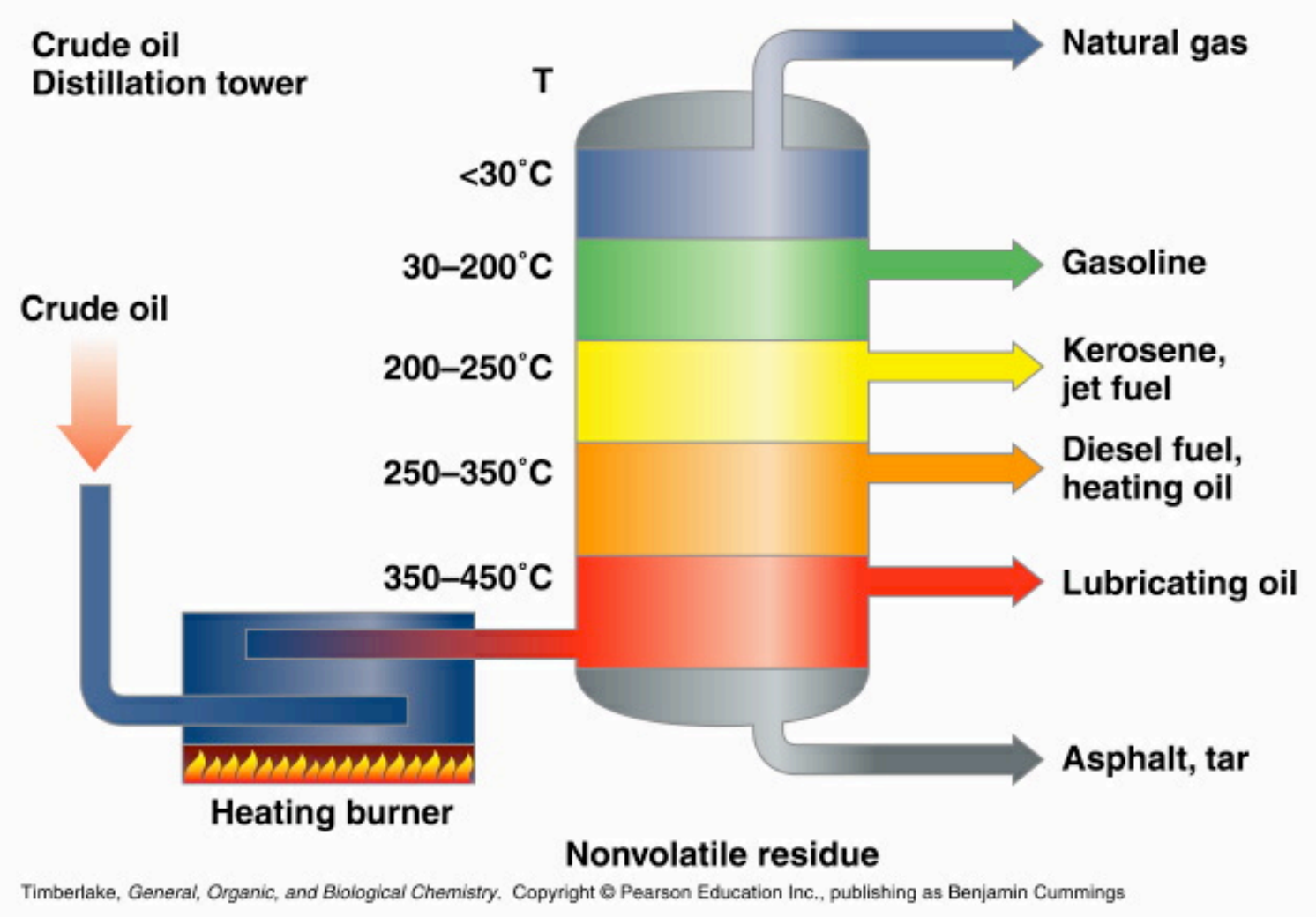
✾0.65-0.70 g/mL

✾means that they float on water

(ever seen an oil spill?)

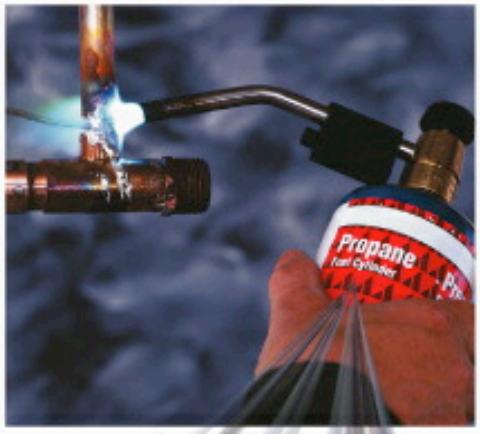
Physical Properties of Alkanes and Cycloalkanes

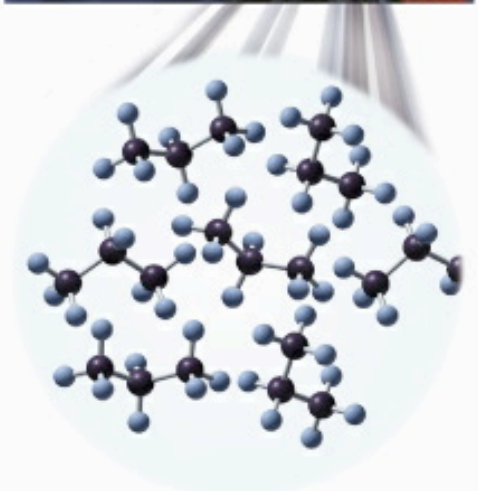
Boiling Points



Chemical Properties of Alkanes and Cycloalkanes

Combustion





After completing two years of coursework, our students apply their skills on-the-job in a summer internship.

They then return to campus the following fall, for one final academic quarter.

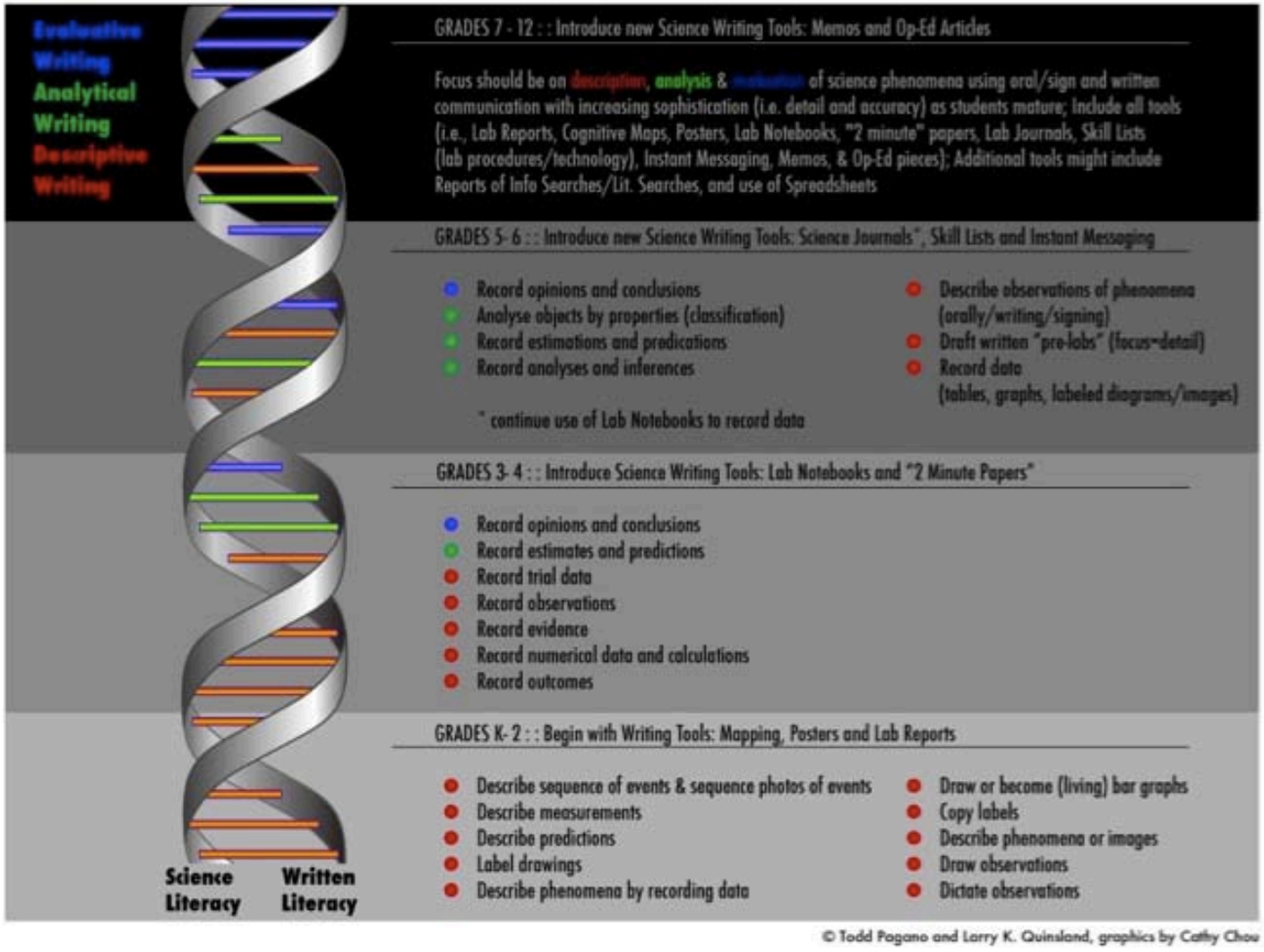
This last quarter is a transition period either to the workplace or to baccalaureate-level coursework.

Either way, I see my role as someone that helps our students to "bridge the gap."

Our Laboratory Applications courses are a special tool that we can use to achieve this goal.

Step Two:
Applying the Facts Through Reading and Writing

Evaluative Writing in the Curriculum



Enhancement of research and opinion-formation skills.

Evaluative Writing in the Curriculum

Build upon the science that students already know so that they can:

1. Understand current events

2. Develop a factual basis for their opinions

3. Enhance their writing and presentation skills

4. Recognize their role in society as scientists

Why?

An informed scientist makes a good impression in an interview.

An informed student has a better chance of success.

An informed student has made a connection.

Example

Now that students understand the use of alkanes as a fuel:

What are the advantages and disadvantages of their use?

What are the long-term implications of their use?

What are the socio-political ramifications related to their consumption?

What possibilities are there for their replacement?

Development of Analytical and Evaluative Skills in Science Writing

Athabasca oil sands activity example

Location of the Athabasca Oil Sands

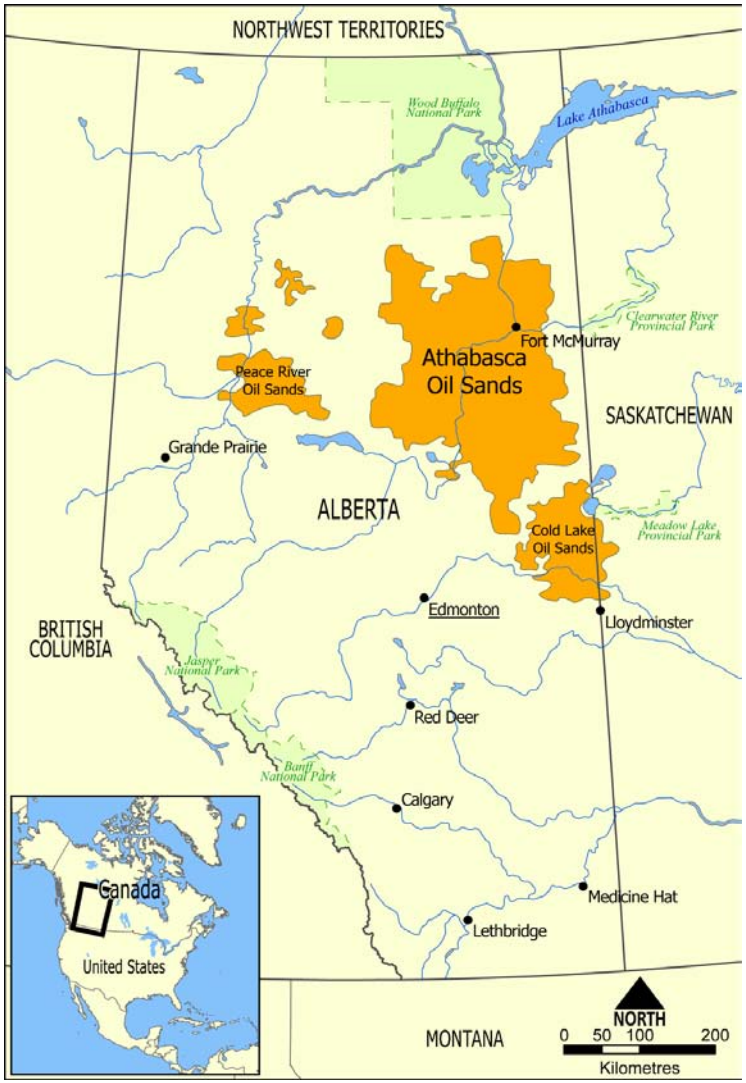
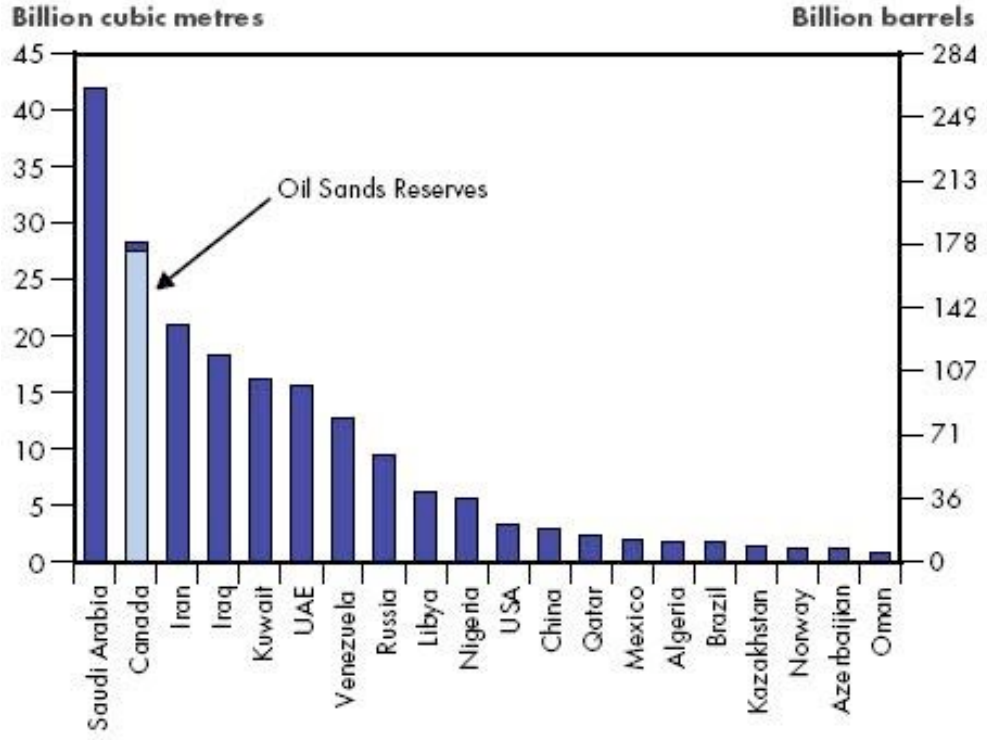


Image source: Faculty of Forestry, University of British Columbia

Images from the Oil Sands Fields in Alberta

Estimated Petroleum Reserves Around the World



Source: BP Statistical Review of World Energy, 2007

Process of Converting Oil from Oil Sand Into Crude Oil

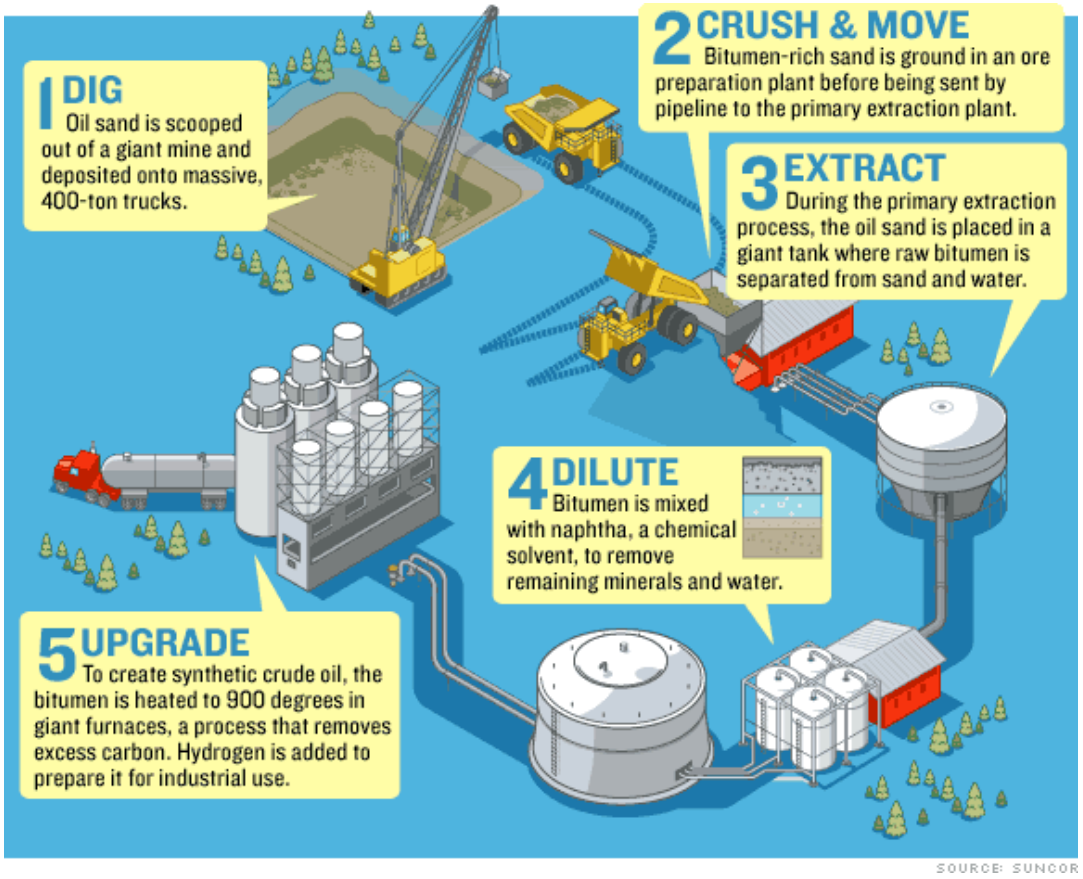


Image source: CNNMoney.com

Oil Sands Controversy

Development of Analytical and Evaluative Skills in Science Writing

Choice of material at appropriate level

Guided reading

Guided writing

Student-led activities

Student-supported critique

Individualized support

Development of Analytical and Evaluative Skills in Science Writing

Typical Course Schedule:

1. Academic term split into two sections

2. Reading and writing assignments in each half have a common theme (e.g., "energy")

3. An exam at the end of each half of the course allows students to sum up all they have discussed and learned.

Development of Analytical and Evaluative Skills in Science Writing

Class 1:
Students receive an article with questions they must answer by the next class period.

Class 2:
All questions are discussed in class to ensure students' understanding of the material.
Students then receive guided writing assignment.

Class 3:
Guided writing assignment is due.

Step Three:
Student-Led Discovery and Presentation

Development of Research and Presentation Skills

Primary Goals

Being able to locate information, to summarize it, and to communicate it to others benefits students in numerous ways:

1. They learn how to find information.

2. They understand how to represent information that is not their own.

3. They know how to present information in the various ways that scientists communicate such material.

Development of Research and Presentation Skills

Secondary Goals

Being required to present this information in lecture or poster format means that students must:

1. Have an immediate command of background facts.

2. Understand the relevance of these facts in current situations.

3. Be able to think on their feet as they teach others and defend their argument!

Global Warming

Researcher / Megan Hartlove
National Technical Institute of Deaf / Laboratory Science Technology

Rochester Institute of Technology R·I·T National Technical Institute for the Deaf

Abstract

> Today, this world is truly impacted by global warming in many different ways.

> The definition of global warming is a global averaged temperature that keeps on increasing in the surface of the Earth.

> The environment, society, and the economy are three of the three things that are affected by global warming

Objectives

The environment, society, and the economy are three of the three things that are affected by global warming.

- The serious effects of global warming on the environment are highly possible in creating severe risks of survival in the future.
- A graph: how much the water has risen over the years.
- The effects on environment are truly impacting society today.
- A graph: As the temperature increases, the plants will be delayed in growth.
- With considerations to the economical issues
- Results of overall impacts
- A graph: Kyoto Protocol
- Discussion: Methane
- Conclusion
- References

Solution

Since there is a very hard way to solve this hot issue, in the subject of economy has mentioned about the president of United States, Bush refused to sign the Kyoto protocol because of economy may sink risky. [8]

There will be a solution if it was not for economical issue. Unfortunately, this will affect on people in the United States because, looking at, how many people do have hybrid in United States, how many people do work for industrial units, how many people do depend on the electric for multi-reasons, and last of all is the farmers will have to reduce their byproducts for their plants to be protected from insects and damage.

Methods

Environment

> The serious effects of global warming on the environment are highly possible in creating severe risks of survival in the future.

> During the spring time, the ice melt 9 days earlier than it did in 150 years old. During the beginning of fall, the freeze gets frozen 10 days later than it did. [2]

> Weather patterns have changed a lot since the early twentieth century, the averaged temperature has risen rapidly in the last few years, in fact, such as "sea levels have risen, on average, between 4 and 10 inches since 1990." [6]

Society

> The effects on environment are truly impacting on society today

> As the temperature increases, the plants will be delayed in growth

> The most obvious health effect "with the increased heat atmosphere, there will be more people who will suffer from heatstroke, heart attacks, and other illnesses that are forced by the heat."[6]

> In the 1995 of July, the heat wave killed more than 700 people in the Chicago area only.

> Not only that, people will be suffered by insects and other pests due to the warmer temperature

Economy

> With considerations to the economical issues

> The people in this world are truly alarmed about economy

> The United States government had to pay over 100 billion dollars for a lot of debris in the coastline of United States that were caused by severe conditions such as hurricanes.

> A critical issue with farmers in the year of 2003. A case in that point, the story of corn the United States is the world's largest production of corn; "they grow 40% of the world's supply…." [4]

> Kyoto Protocol

Figure 1: Rise in sea water during the past two centuries. [6]

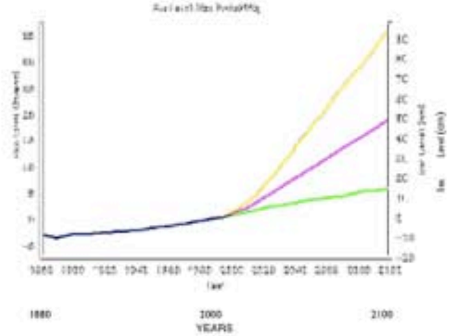
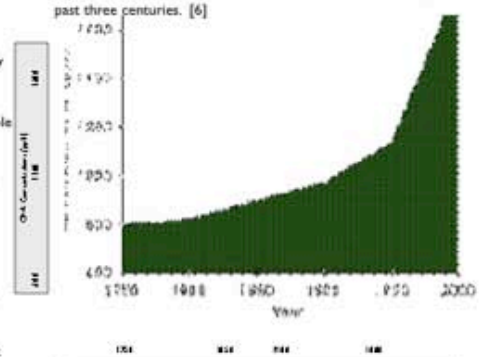


Figure 2. Rise in atmospheric methane concentration during past three centuries. [6]



References

1. http://www.effectofglobalwarming.com/global-warming-statistics.html
2. http://www.effectofglobalwarming.com/global-warming-effects.html
3. http://www.effectofglobalwarming.com/global-warming-statistics.html
4. http://www.organicconsumers.org/corp/global_warming_farmers.cfm
5. http://www.umich.edu/~gs265/society/greenhouse.html
6. http://www.gdsciences.com/gds_st.htm
7. http://www.msnbc.msn.com/id/8422343
8. www.envirolink.org/orgs/edf/sitemap.html
9. http://www.bsalanesis.com.ezproxy.rit.edu

Results

Figure 3. Depiction of causes and effects of the increase of greenhouse gases in the atmosphere. [6]

Discussion:

> An interesting fact: the name of chemical, Methane (it is a colorless, odorless, and flammable gas. It is made from the decomposition of plants.

> When bacteria that breakdown organic matter in wetlands & it is found in "farm animals"

> Since the year 350-500 million tons of methane have been added to the air…[6 and 9]

> Furthermore interesting fact, farm animals do release methane by belching. In one day, a cow can release ½ pound of methane into the air. Let's imagine that out of there are 1.3 billion cattle each burping methane several times per minute! [6]

Conclusion

Earth has the great issue of global warming that seems cutting into the span of living because people's lives are effortlessly absorbed by the environment, society, and the economy. Honestly, this is deeply considered that people should focus on the environment first because people all want to live in this world with the feeling of secure and extend the span of living. The only way people can survive is to take a critical issue of global warming seriously.

Conclusion

Relevance, accessibility, and **engagement** are important keys to teaching **any** student.

These goals can be reached by having students:

1. Learn facts,

2. Reflect upon facts,

3. Communicate these facts to others.