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

$$C_nH_{2n+2}$$
In-Class Problem 1
**IUPAC Nomenclature System**

**IUPAC means**

“International Union of Pure and Applied Chemistry”

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Line-Bond Formulas

Chemists use line-bond formulas to draw molecules quickly.

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

Process of Converting Oil from Oil Sand Into Crude Oil

1 DIG
Oil sand is scooped out of a giant mine and deposited onto massive, 400-ton trucks.

2 CRUSH & MOVE
Bitumen-rich sand is ground in an ore preparation plant before being sent by pipeline to the primary extraction plant.

3 EXTRACT
During the primary extraction process, the oil sand is placed in a giant tank where raw bitumen is separated from sand and water.

4 DILUTE
Bitumen is mixed with naphtha, a chemical solvent, to remove remaining minerals and water.

5 UPGRADE
To create synthetic crude oil, the bitumen is heated to 900 degrees in giant furnaces, a process that removes excess carbon. Hydrogen is added to prepare it for industrial use.

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 for the Deaf / Laboratory Science Technology

**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. The subject of economy has mentioned about the president of the United States. Bush refused to sign the Kyoto protocol because of economy may cost risky.

There will be a solution if it were not for economical issues. 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 in 1900.
- The beginning of fall, the freeze gets frozen 10 days later than it did.
- 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.

**Society**

- The effects on environment are truly impacting society today.
- As the temperature increases, the plants will be delayed in growth.
- The most obvious health effect: with incremental heat, there will be more people who will suffer from heatstroke, heat attacks, and other illnesses that are forced by the heat.
- In the 1950s, 1500 people were killed more than 790 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 debts in the coastal line 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.

*Kyoto Protocol*

**Results**

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

![Figure 1: Rise in sea water during the past two centuries.](image1.png)

Figure 2: Rise in atmospheric methane concentration during past three centuries.

![Figure 2: Rise in atmospheric methane concentration during past three centuries.](image2.png)

**Discussion**

- An interesting fact: the name of chemical Methane (CH₄) is a colorless, odorless, and flammable gas. It is made from the decomposition of plants.
- What bacteria is this breakdown organic material in wetlands & is found in “farm animals.”
- Since the year 2000, billion tons of methane have been released to the air...

> For thousands of years, farm animals do release methane by belching. In one day, a cow can release 7% pounds of methane into the air. Let's imagine that, out of there, there are 1.3 billion people each exhaling methane several times per minute.

**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.