Right-handed Sugar Doughnuts: Nutritional Food for Undergraduates and Their Faculty

Thomas J. Wenzel
Department of Chemistry
Bates College
Lewiston, Maine
Enhancing Research
in the Chemical Sciences at Predominantly Undergraduate Institutions

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Undergraduate research is an inquiry or investigation conducted by an undergraduate that makes an original or creative contribution to the discipline.
Alanine

\[
\begin{align*}
\text{H-O-C-} & \text{C-NH}_2 \\
\text{CH}_3 & \\
\end{align*}
\]
Amino Acid

Amine Carboxylic Acid

Carboxylic Acid

Amine

Amino Acid
Non-superimposable mirror images

- Enantiomers
- Optical Isomers
- Chirality
53 Post-classical Developments. The experimental image of Visnu Visvarupa at Deogarh, U.P.

Courtesy Odette Vernet
Random Bit of Chemical Trivia

Organic = (RBCT)^n

Where n is a very large number
Ethanol

**H-O-CH₃CH₂-CH₃**
Crown Ether
β-Cyclodextrin
Lanthanides
Education is what’s left over after you’ve forgotten everything that you learned.
Traditional Science Courses

*Knowledge outcomes* – “..particular areas of disciplinary or professional content that students can recall, relate, and appropriately deploy.”

Research Experience

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From:

Analytical Chemistry Course

- Analysis of benzene and toluene in air
- Analysis of trihalomethanes in drinking water
- Amino acid content of foods (popcorn and beer)
- Caffeine, theophylline, and theobromine levels in chocolate
- Analysis of nitrate and nitrite in hot dogs
- PAHs in burgers, oysters, diesel exhaust and wood smoke
- Toxic metals in sludges from waste-water treatment plants
Cooperative Learning

• Class divided into small groups (3-5)
• Presented with a problem or question
  – I serve as a facilitator
  – If one student sees the point, she or he is to explain it to the others
  – When the groups appreciate the point, I call timeout and highlight the concept
Advantages of Cooperative Learning

• More “teacher” resources because the students are teachers as well
• Less formal
• Active learning – I know what they do/don’t understand – they know what they do/don’t understand
• Students spend more time on class material
• Cooperation, not competition
• Students learn more
Outcomes of Cooperative Learning from Prior Research Studies

- Statistically significant improvements in academic achievement
- Better reasoning and critical thinking skills
- Proposed more new ideas when presented with problems
- Transferred more of what was learned in prior situations to new problems
- Reduced levels of stress
• Promotes more positive attitudes toward subject and instructional experience – faculty get to know students better

• Decreased absenteeism

• Improved student commitment

• Greater motivation toward learning

• Better student retention (especially for women and minorities)
  - Socially involved
  - Academically involved
Introductory Course

- Thematic version of general chemistry – fundamentals of chemistry related to the study of the environment
- Counts for the chemistry major
- Pre-requisite for all upper-level chemistry courses
- 60 students in class (20/lab)
Course Goals

• Learn fundamental concepts of chemistry
• Learn that science does not know all the answers
• Participate in and learn about the process through which scientists undertake investigations and create knowledge
• Learn in interaction with, rather than in isolation from, other students
• Appreciate that science occurs in a social context
Laboratory Project

• Do plants grown in soil contaminated with lead take up more lead?

• Does the uptake of lead vary with the acidity of the rain water?
Some questions the students need to answer:

- What to grow?
- What soil to use?
- How to mimic acid rain?
- How much lead to add?
- What watering schedule?
- What to use as a control?
Some advantages of the project:

- Conduct a real investigation
- Ask/answer questions
- Design experiments
- Unanticipated problems
- Teamwork
- Communication – Informal/formal
- Opportunity for leadership
Uncertainty

- 26 of 29 contaminated samples had higher lead
  - other three?

- Acidity trend is inconclusive
Summary Comments

• We need to design an undergraduate curriculum in which students begin scholarly-like activities in their first year and progress through to an original project by their senior year.

• We need to encourage cooperation and collaboration among our students.