Update on Green Chemistry Education

IGSS’09

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Why Green Chemistry?
How is Academia Responding?

- Graduate and Undergraduate Research
- Undergraduate Education
- High School???
Is it Ideal for Teaching?

- Green chemistry is ideal for teaching laboratory chemistry:
  - green methods minimize hazards vs. trying to prevent exposure
  - safety procedures are potentially fallible

- Green chemistry teaches:
  - at least as many core concepts and techniques as a traditional curriculum
  - state-of-the-art strategies and techniques
  - critical thinking skills
  - objective discussion of chemical hazards
  - how to make informed chemical decisions based on green principles
  - transform student perceptions about the role of chemistry in society
Effective Preparation of Undergrads?

- Green chemistry programs produces scientists:
  - well-prepared for the quantities, techniques, and procedures more typically encountered in graduate or industrial settings
  - with skills needed to excel in research and development programs that connect to clean technology or sustainability
  - to focus on innovation that leads to higher value products, improved economics and greener solutions
  - prepared for the challenges of the 21st century
  - promote chemistry as a responsible science
More Chemistry Students?

- Green chemistry is:
  - attracting new students into chemistry
  - inspiring students to stay engaged with chemistry
# Academic Preparation

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<tr>
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<th>Traditional</th>
<th>Green</th>
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<tbody>
<tr>
<td>Fundamentals of chemistry</td>
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<td>Practical lab procedures</td>
<td>+</td>
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<td>Green chemical concepts</td>
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<tr>
<td>Process chemistry concepts</td>
<td>-</td>
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<tr>
<td>Waste generation/disposal</td>
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<td>Safety</td>
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<tr>
<td>Realistic scale and apparatus</td>
<td>+/-</td>
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<tr>
<td>State-of-the-art curriculum</td>
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Green Chemical Education – Accomplishments

- The first comprehensive green organic chemistry laboratory program was established in 2000 at the U of O by Ken Doxsee and Jim Hutchison
Green Chemical Education – Accomplishments

First edition 2004

leading non-majors text has green chemistry material associated with each chapter
Green Chemical Education – Accomplishments

- NSF sponsored Green Chemistry in Education Workshop
- University of Oregon
- This summer will be 9th workshop
- Will have involved 150 institutions
- Workshop setting for faculty to develop green chemistry skills

Center for Workshops in Chemical Sciences
Green Chemical Education – Accomplishments

Green Education Materials (GEMs) database (2005)

http://greenchem.uoregon.edu/gems.html

Dr. Julie Haack
Assistant Department Head
University of Oregon
Who Uses Green Chemistry Laboratories?

- To seed the growth and use of green chemistry in the classroom, a catalog of institutions currently implementing green labs will be created to demonstrate the versatility of each lab.

- With your help, we can generate a new section of GEMs titled “Schools” where each lab’s individual page contains a log of current institutions and instructors using the procedure.

http://greenchem.uoregon.edu/WhoUsesGreenChemLab/

Dana Garves:
Developing and implementing green chemistry into high school curriculum.
Green Chemical Education – Accomplishments
Green Chemical Education – Challenges

- These numbers are promising!
- But few chemistry programs that have incorporated green chemistry across the entire organic curriculum
- Fewer still which have broad incorporation across the core chemistry curriculum
- What about high schools?
How Does Incorporation Occur?

- Typically the incorporation of green chemistry experiments is done by instructors on a case-by-case basis, not as part of a larger cohesive effort.

- Most institutions that have incorporated green chemistry experiments have taken one of two approaches.
  - Sprinkle in a few experiments into their curriculum by eliminating a few experiments that were not well liked, or that did not work well
  - Direct replacement of selected non-green experiments with greener versions.
How Green?

- “How important is it to be as green as possible?”

- Students need multiple exposures to concepts in order for those concepts to be understood, integrated with other knowledge, and retained.
Curricular Cohesion?

- This is most practically achieved if the student encounters a substantial amount of green chemistry in the organic chemistry class, followed by systematic repeated exposure to sustainability topics in subsequent coursework.
Green Chemical Education – What’s Next?

- Support increased incremental adoption
- Determine the drivers (internal and external) to institutions that will drive greener curricula
- Use those to enhance adoption

- What will be the impetus for more total adoptions and curricular cohesion?
Next Steps - Enable Broader Acceptance, Adoption of a Greener Curriculum

- Develop more labs and other education materials
- Disseminate via the GEMs database
- Promote the growth of this community through workshops, symposia and collaborations
- Build the “business case” for green chemistry
Who are the Leaders in Green Chemistry Education?