



Greening the Chemistry Curriculum in Michigan

21st century workforce

**the role of Green Chemistry in the education of the new
generation: values, concerns & hurdles, solutions**

1ST MI Green Chemistry Conference

Detroit September 25th, 2009



Panelists

- Julie Haack

Assistant Department Head,
Chemistry, University of Oregon

- Amy Cannon

Co-founder and Executive Director
Beyond Benign

- Moderator: Dalila Kovacs

Associate Professor
Grand Valley State University, MI



Hot Academic Jobs of the Future: Green chemistry

Lee Roberts in *Chronicle of Higher Education*, July 10, 2009

<http://chronicle.com/weekly/v55/i41/41b02201.htm>

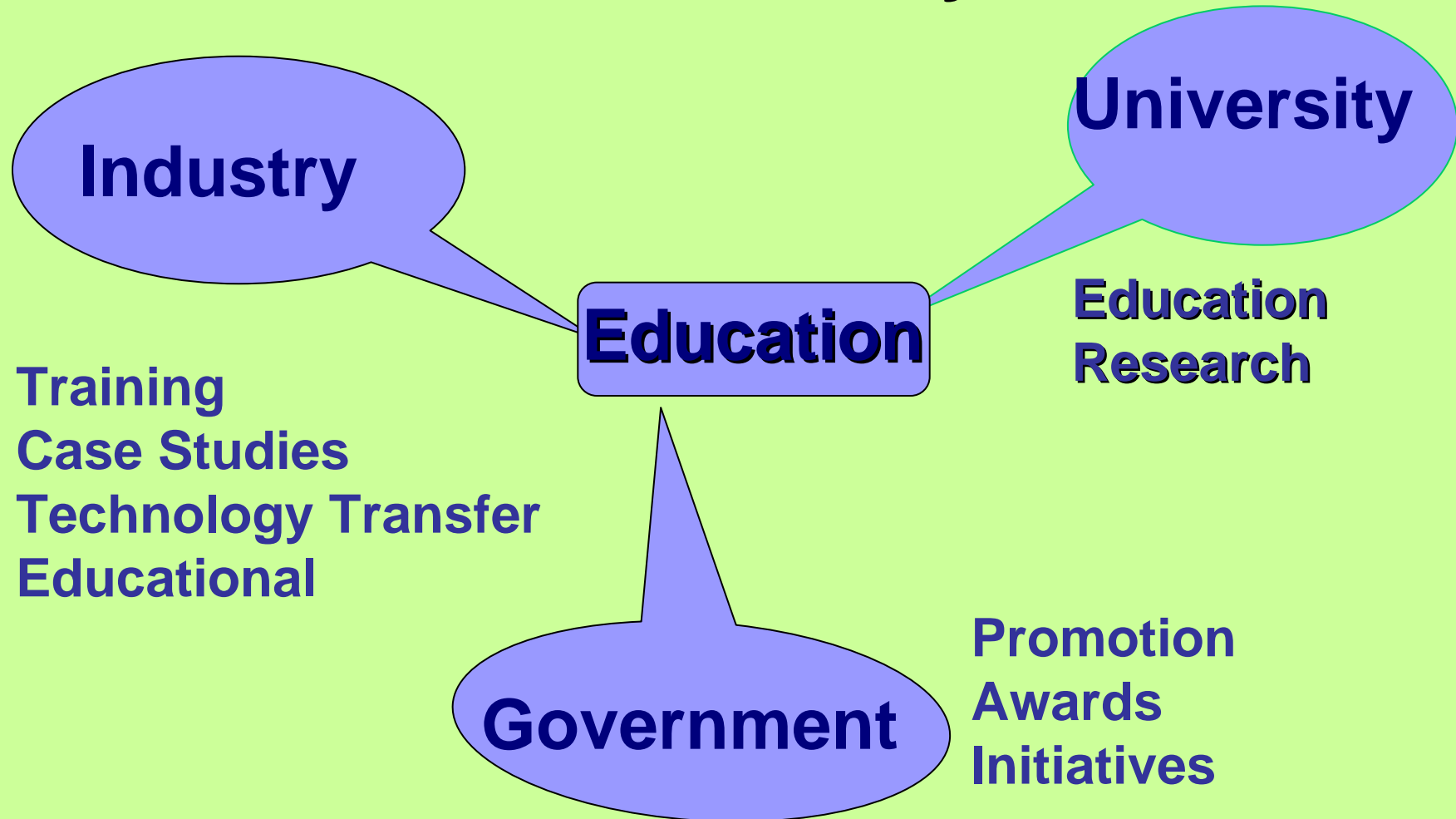
“Green chemistry focuses on eliminating the use of toxic chemicals in chemistry without stifling scientific progress. Paul T. Anastas, a Yale University chemist, founded the field in 1991. **As it grows in importance, more institutions are expected to offer master's degrees and doctorates.** Among the universities with green-chemistry programs are Carnegie Mellon and Yale Universities and the Universities of Oregon, Scranton, and Massachusetts at Lowell.

Terry Collins, a chemistry professor at Carnegie Mellon who heads the university's Institute for Green Science, thinks the intellectual rationale for the field is strong. **“It hasn't gotten a lot of federal support, but I think that's going to change,”** he says. One reason: Mr. Anastas has been nominated by President Obama to head the Environmental Protection Agency's Office of Research and Development”

Goals: Identify...

- existing resources to support GC teaching in MI
- pathways to access & share
- means to contribute
- viable routes to develop the integration of green chemistry in the main stream education program at all levels in MI and elsewhere

Problem: Who is responsible for the education the 21st century work force?



GC @ GVSU

- *Two new courses: CHM 311 ‘green chemistry & industrial process’ and CHM 180 ‘introduction to green chemistry’*
- Draft a proposal for a **green chemistry certification program:** designed to be completed in one calendar year; an attractive option not only for our students but also for mid-career chemists looking to competitively re-lunch their carrier
- Organize a **conference and issue an e-newsletter:** specifically designed to respond to item #7 on the Action Plan for Advancing Michigan Green Chemistry Research, Development and Education (July '08): *Establish a Green Chemistry education network and opportunities.*

Green Chemistry

special topics F06

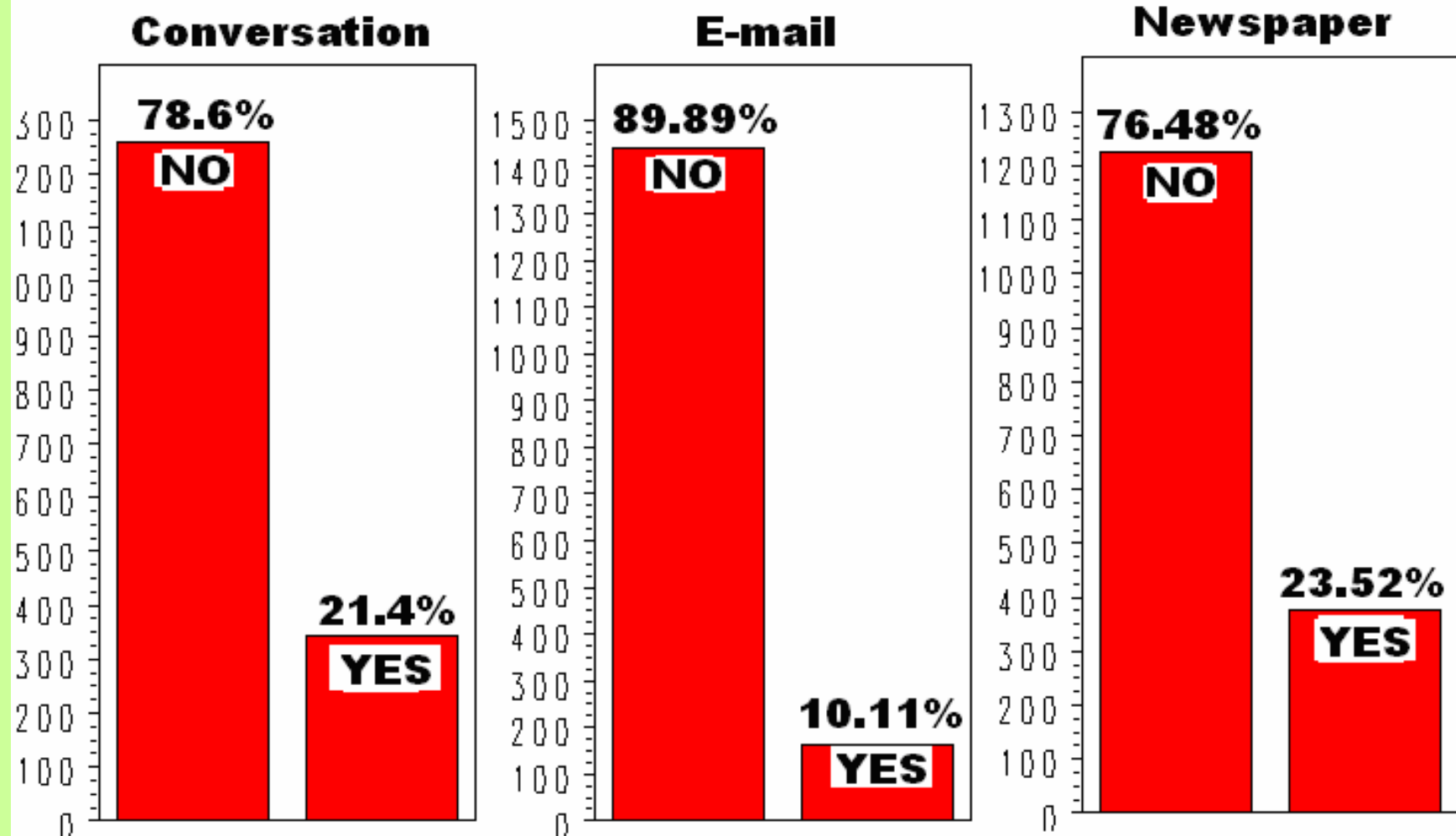
12 students enrolled, majoring in Biology (2), chemistry (6), biomedical sciences(4), natural resources management (1).

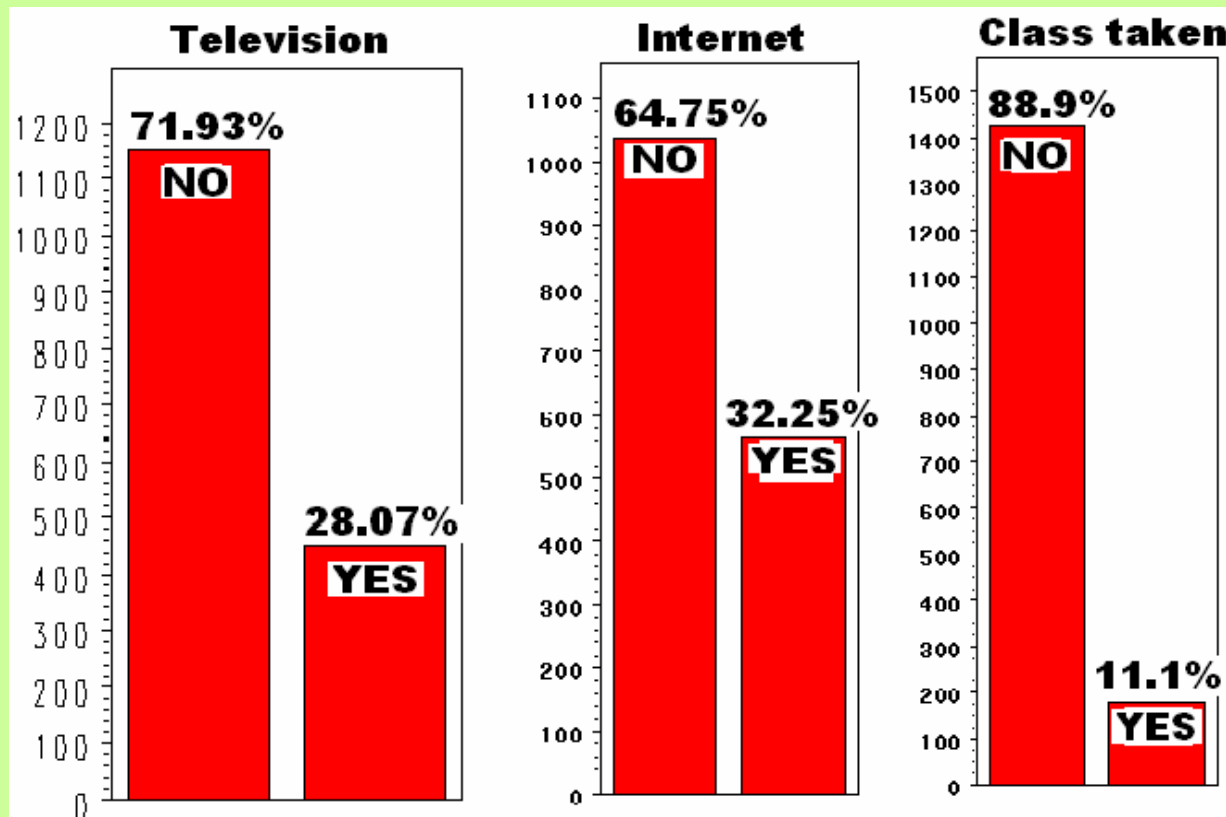
Textbooks: *Green Chemistry: Theory and Practice*, P. T. Anastas and J. C. Warner, and *Introduction to Green Chemistry*, A. S. Matlack.

Students created and distributed a campus wide survey to test the knowledge about green chemistry.

The overwhelming response (over 1,600) was both amazing and shocking; the results indicate a general lack of formal education information. When asked where, if ever, the '*green chemistry*' term was encountered, the many media sources listed in the questions (TV, Internet, email, newspaper, etc) were far ahead of the organized educational settings offered by college courses.

Where did you hear about 'Green Chemistry'?







Green Chemistry & Industrial processes Winter '09 CHM 311

- main goal is to teach elements of industrial chemistry appropriate for the 21st century and to support students to manifest their creativity in applying the green chemistry principles to existing, unsolved problems in industrial-scaled chemical processes)
- designed to present new, global perspectives on how chemistry *can* and *should* be performed with no negative consequences on environment and population and with increased benefits on the human kind and our planet.



CHM 311 Objectives

At the end of the semester, the student should be able to:

- locate, evaluate and use the available information connected with green chemical processes.
- integrate the are of Green Chemistry into student's main area of expertise
- integrate the variety of data addressing both the effect of humans on the environment as well as the effect of the environment on the humans using green chemistry principles.
- demonstrate understanding of the important role chemistry and its industrial applications play in our everyday lives
- evaluate the 'greenness' of a typical industrial process

Schedule/Topics:

Date		Topic
Week 1	Chapter 10 Lancaster	The Future is Green: an Integrated approach to a greener Chemical Industry
UNIT 1		
	Chapters 1-3 Anastas	Principles of Green Chemistry
	Chapter 1 Lancaster	
Week 2	Chapter 4-5 Anastas	Principles of Green Chemistry, Evaluating the Effects of Chemistry
	Chapter 2 Lancaster	Waste: Production, Problems & prevention
	Chapter 6-8, 10 Anastas	Evaluating Feedstock, Starting Materials, Reaction Types; Methods to Design Safer Chemicals, and Future Trends
2 UNIT 2		
Week 3	Real World Experience I	Green Chemistry in West Michigan-introduction/presentations
Week 4	Chapter 3 Lancaster	Measuring & Controlling Environmental Performance
Week 5	Chapter 4 Lancaster	Catalysis & Green Chemistry
Week 6	Chapter 5 Lancaster	Organic Solvents: Environmentally Benign Solutions
Week 7	Real World experience II	Student presentation of individual projects-Progress report
UNIT 3		
Week 8	Chapter 6 Lancaster	Renewable resources
MID TERM EXAM		
Week 9 Spring Break		
Week 10	Mid Term assignments	Student presentations-Presidential Green Chemistry award
week 11	Chapter 7 Lancaster	Emerging Green Technologies & Alternative Energy Sources
Week 12	Chapter 8 Lancaster	Designing Greener Processes
		Selected Green Chemistry Presidential Awards
Week 13	Chapter 9 Lancaster	Industrial Case Studies
		Selected Green Chemistry Presidential Award
UNIT 4		
Week 15	Real World experience III	Student presentation of individual projects-Final
Week 16	FINAL EXAM	



GVSU network

Annis Water Resources Institute
(AWRI)

<http://www.gvsu.edu/wri/>

The Michigan Alternative and
Renewable Energy center
(MAREC)

<http://www.gvsu.edu/marec/>

West Michigan Science & Technology
Initiative (WMSTI)

www.wmsti.org

Herman Miller www.hermanmiller.com

Crystal Flash www.crystalflash.org

Crutchall www.recycleroofs.com

Xtendercorp, www.xtendercorp.com

Barrier Technology, www.barriertec.com

Student work: topic choices

- Degradable Biomedical supplies: sutures, drug delivery devices and dialysis
- Lumber preservation
- Vegetable-based resins
- Tires disposal
- Green Cement
- Polystyrene alternatives
- Biodegradability of polymers
- Green car-racing
- Paper manufacturing
- Spray-paint application
- Starch-based polymers in films & bags
- Enzymatic catalysis



Pollution Prevention, Green Chemistry and Green Engineering

- designed particularly for **freshmen**, Winter 09
- prepared via a service contract with Michigan Department of Environmental Quality
- class will be offered again Winter 10, while the curricular process is successfully completed

Objectives CHM 180

- CHM 180 is designed to provide the student with an overview of the fundamentals of pollution prevention, green chemistry and green engineering.
- The student should gain a greater appreciation of how improvements and modifications are being made in both research and manufacturing to maintain and even enhance environmental quality. It may also assist students in choosing a professional career.



Content

Class Dates and Tentative Topics

January 08	Unit 1 - Introduction to concepts of class. <u>Guest speaker</u> , Clinton Boyd from the Sustainability Research Group.
January 15	Unit 1 - Properties and fates of environmental contaminants
January 22	Unit 2 - Humans - Industrial activity and the environment; humans pollutants.
January 29	Unit 2 - Improving manufacturing through green alternatives. Economics
February 05	Unit 2 - Sustainability and recycling.
February 12	<u>Tour</u> of MAREC (Michigan Alternative and Renewable Energy Center), Muskegon
February 19	Unit 3 - Water - Sources of water pollution, types of contaminants, treatment.
February 26	Unit 3 - Treatment techniques. <u>Tour</u> of Wyoming Clean Water Plant
March 05	No class - Spring Break
March 12	Unit 4 - Air - Sources of air pollution, acidic aerosols, ozone hole. Climate change
March 19	Unit 5 - Energy - Types of energy sources and their environmental impact.
March 26	<u>Guest Speaker</u> , Dr. Rick Rediske of GVSU's AWRI (Annis Water Resources Institute). <u>Guest Speaker</u> , Dr. David Shonnard from Michigan Technological University
April 02	Unit 5 - Treatment of energy production waste; alternative energy sources. <u>Tour</u> of Zeeland Power Plant.
April 09	Unit 6 - Agriculture - Pollution from fertilizers and pesticides. Impact on nature
April 16	Unit 6 - Green alternatives for fertilization and pest control.

Certification in green chemistry

Benefits and Career Opportunities:

- A Certificate in Green Chemistry provides a major advantage to an applicant on the job market. The green job market involves a focus on environmentally responsible production.
- Entry-level positions in the field, such as chemical analysis, testing, quality control, and technical service are expected to list '*knowledge of green chemistry is desired*' (Cue Berkely, Pfizer, 2007) in job posting in the near future, as the industry recognizes its social responsibilities.
- Students are to respond to the challenge to learn while the industry is to respond to the challenge to hire.
- 'Green' companies are seeking employees with knowledge of the green chemistry principles and understanding of green chemical design.
- The certificate will augment career opportunities in public, private, and nonprofit organizations and agencies interested in environmental issues and in the promotion of sustainability.



GVSU proposal:

Required:

- CHM 321. Environmental Chemistry; 3 credits
- CHM 311 Green Chemistry & Industrial processes; 3 credits
- CHM 399 Readings in Chemistry; 1 credit
- CHM 490 Chemistry Laboratory Internship and/or
- CHM 499 Investigation Problems; 3 credits

And one of the 3 credit courses listed below:

- CHM 322 Environmental Chemical Analysis; 3 credits
- NRM 330 Environmental Pollution; 3 credits
- NRM 451 Natural Resources Policy; 3 credits
- GPY 412 Global Environmental Changes; 3 credits
- ECO 345 Environmental and Resource Economics; 3 credits
- GEO 300 Earth and Environment; 3 credits

Networking & Outreach

- *Michigan Green Chemistry Education Network Conference (5/09)*

- *MIGreen e-newsletter (09)*

<http://www.gvsu.edu/cms3/assets/1ACDDEF0-A15A-67B1-F268BE06B2416593/Newsletter.pdf>







MI Green Chemistry Education Newsletter



keep the network up to date with current green chemistry activity and events.

- designed to continue the connections and collaborations made during the MI Green Chemistry Education Conference
 - highlights the current work and future projects in green chemistry of various educators, researchers, legislators, and industrial professionals in MI.
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- If you wish to have your work in green chemistry included in an upcoming edition, please submit a short summary to MIGreenChem@gmail.com. All members of the green chemistry community are encouraged to submit news items, regardless of the scale or scope (including research, education, or other areas). Photos of your class, group, or project are welcome.
 - If you are looking for colleagues to collaborate with on future projects at your school or other institution, submit these requests as well.

Summary: GC @ GVSU

- The **two new courses** bring a significant and beneficial contribution to the education of our students and constitute a model to be build upon for other institutions interested to integrate green chemistry in their curriculum. We anticipate significant changes in the ACS chemistry program accreditation to include green chemistry and act proactively to the benefit of our students.
- The **certification program** has an unique design and rigor not only by inclusion of required courses outside the chemistry realm but mainly by the research experience required as fundamental part of the program. Designed to be completed in one calendar year, is an attractive option not only for our students but also for people looking to re-lunch their carrier and become competitive on the job market.
- The **conference and newsletter** were specifically designed to respond to item #7 on the Action Plan for Advancing Michigan Green Chemistry Research, Development and Education, July 2008 *Establish a Green Chemistry education network and opportunities*. We are excited about the enthusiasm and interest of the participants' response and eager to continue our work to toward promoting and supporting green chemistry education in MI.

Where do we go from here?

- **What is the role of Green Chemistry in the education of the new generation?**
- **What our common values?**
- **What are our concerns & hurdles?**
- **What solutions could we find?**