Green Chemistry in the Classroom: Tools and Networks that Catalyze Adoption

Julie A. Haack

Green Chemistry in Higher Education
October 26, 2010
UC Berkeley

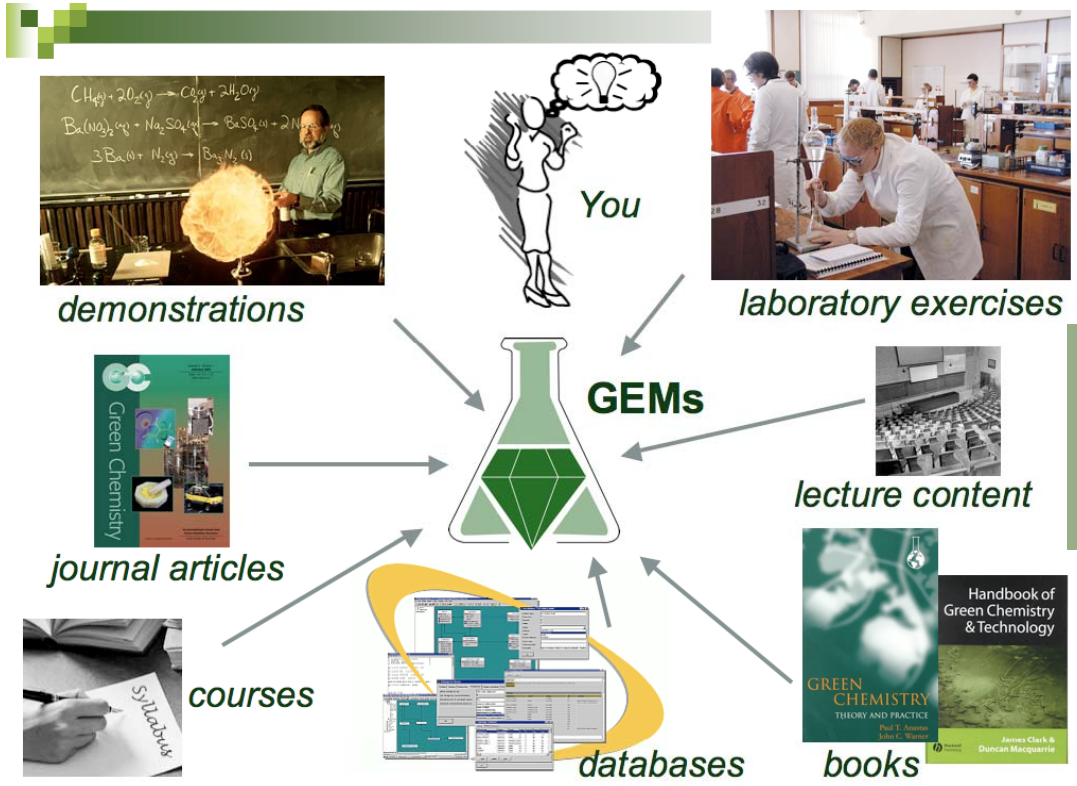
UNIVERSITY
OF OREGON

Transformation requires more than content alone

Incorporation into the Curriculum

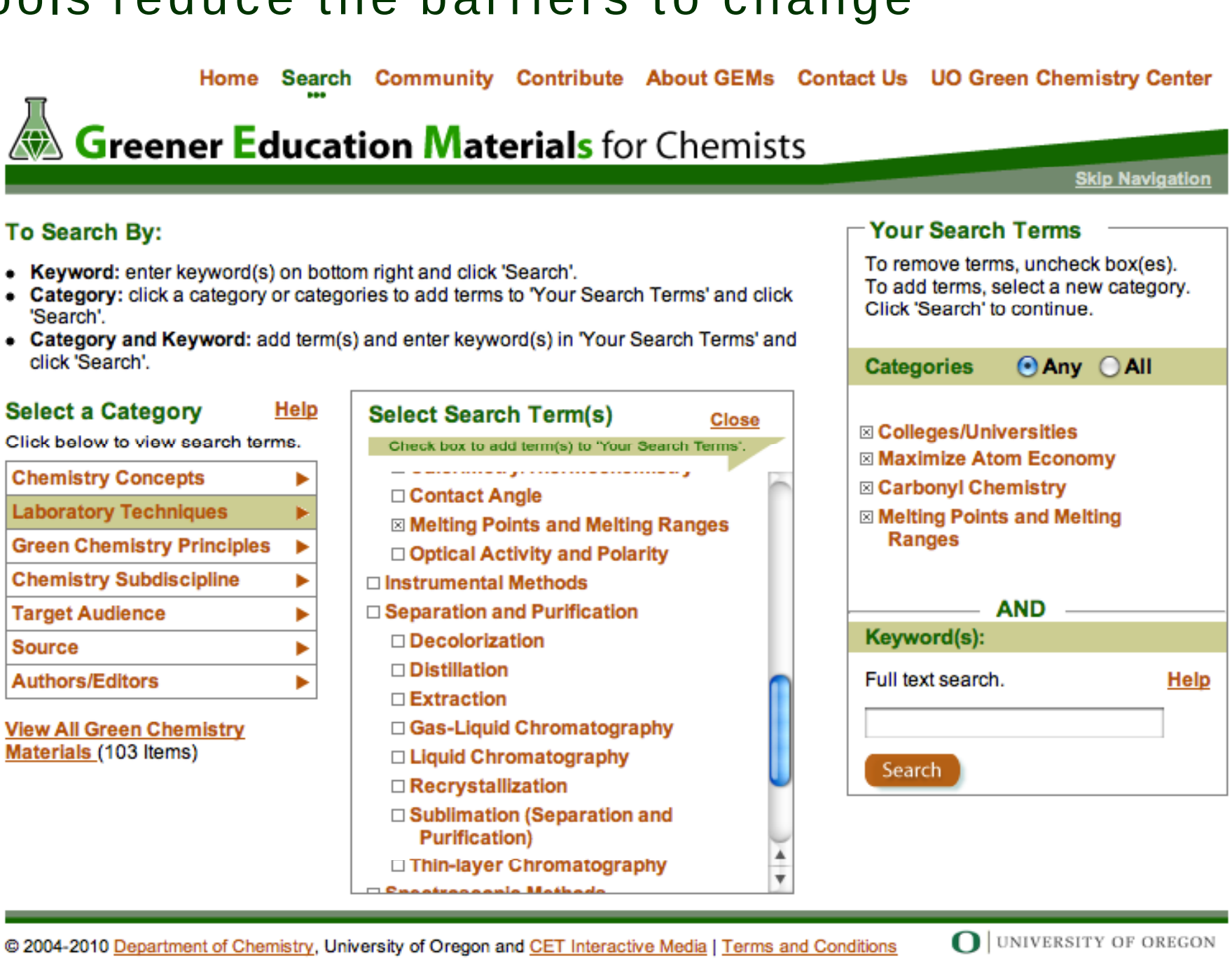
Models for Incorporation *(context)*

Green Chemistry *(knowledge and understanding)*



Educational Materials and Tools *(variety)*

Tools reduce the barriers to change



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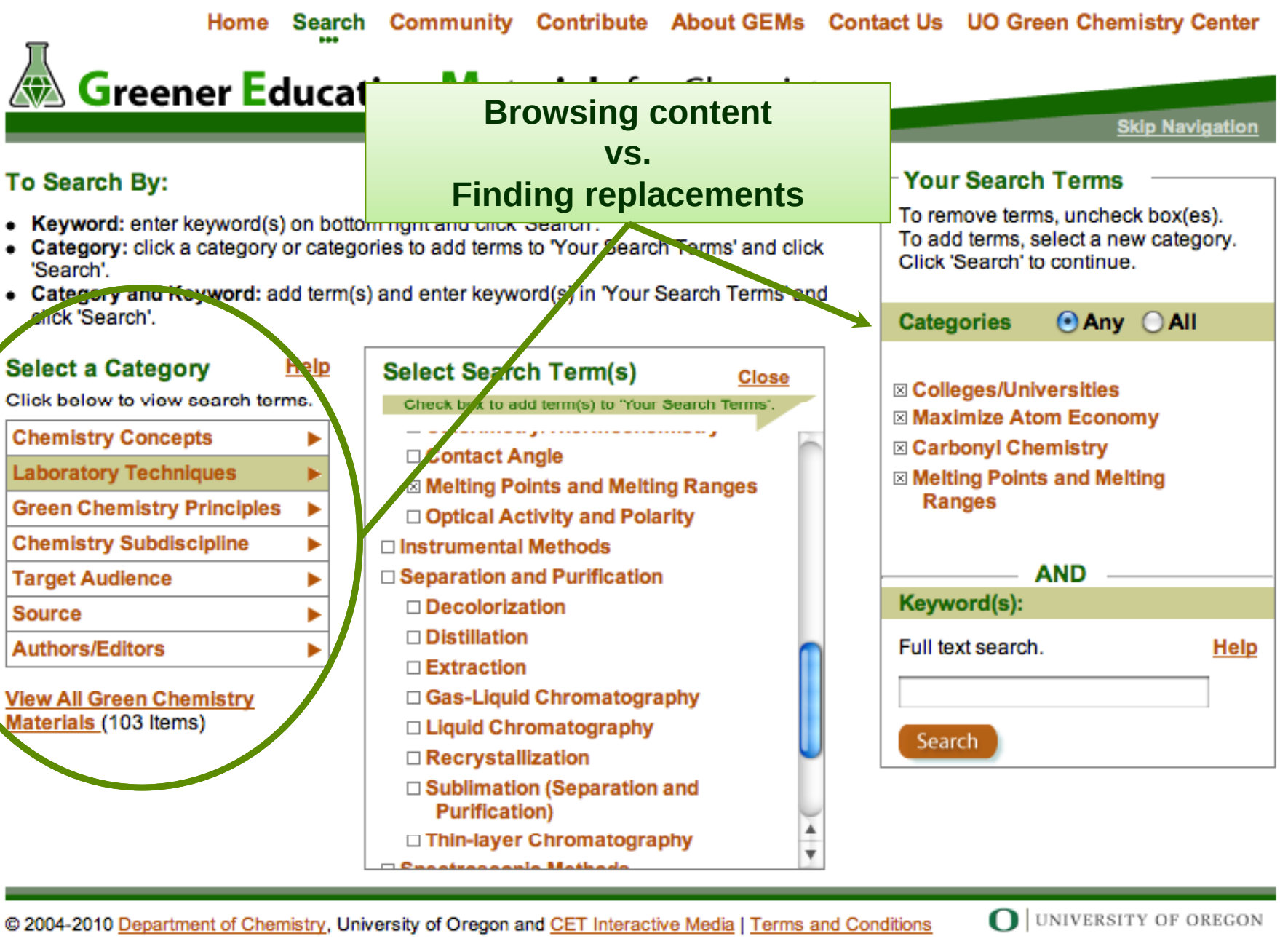

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Solventless Reactions: the Aldol Reaction

Laboratory Procedures (PDF)

Author Contact: hutch@uoregon.edu

Summary

This experiment provides a rare example of a solventless reaction. Students mix together two solids, an aldehyde and a ketone, that form a low-melting eutectic mixture. Addition of a small amount of powdered sodium hydroxide to the liquid initiates an aldol condensation between the two components, forming a solid product. A brief rinse of the solid with dilute aqueous HCl affords the product in high yield and purity. A video clip is available to highlight the features of this rapid and convenient synthesis.

The solventless aldol condensation provides lessons on several key topics. Given that nearly all chemical transformations carried out in undergraduate teaching laboratories rely on solvent to bring the reactants together, this exercise provides a unique opportunity to discuss the role of solvents and reexamine the need for solvents. The exercise also provides an excellent opportunity to discuss and illustrate melting points, eutectic mixtures, and melting point depression. Finally, the condensation is an example of a reaction with high atom economy. The link to the laboratory procedure includes post-lab questions.

Summary prepared July 2006 by James E. Hutchison, Department of Chemistry at the University of Oregon.

Category Descriptors

Chemistry Concepts
- Aldehydes/Ketones
- Carbonyl Chemistry
- Melting Points and Ranges
- Phases/Phase Transitions

Laboratory Techniques
- Melting Points and Melting Ranges
- Recrystallization

Green Chemistry Principles
- Maximize Atom Economy
- Prevent Waste
- Use Safer Solvents/Reaction Conditions

Chemistry Subdiscipline
- Organic Chemistry

Target Audience
- Colleges/Universities
- Secondary Schools

Source
- Books

Resource for Questions

Green Chemistry Connection

Visual Checklist

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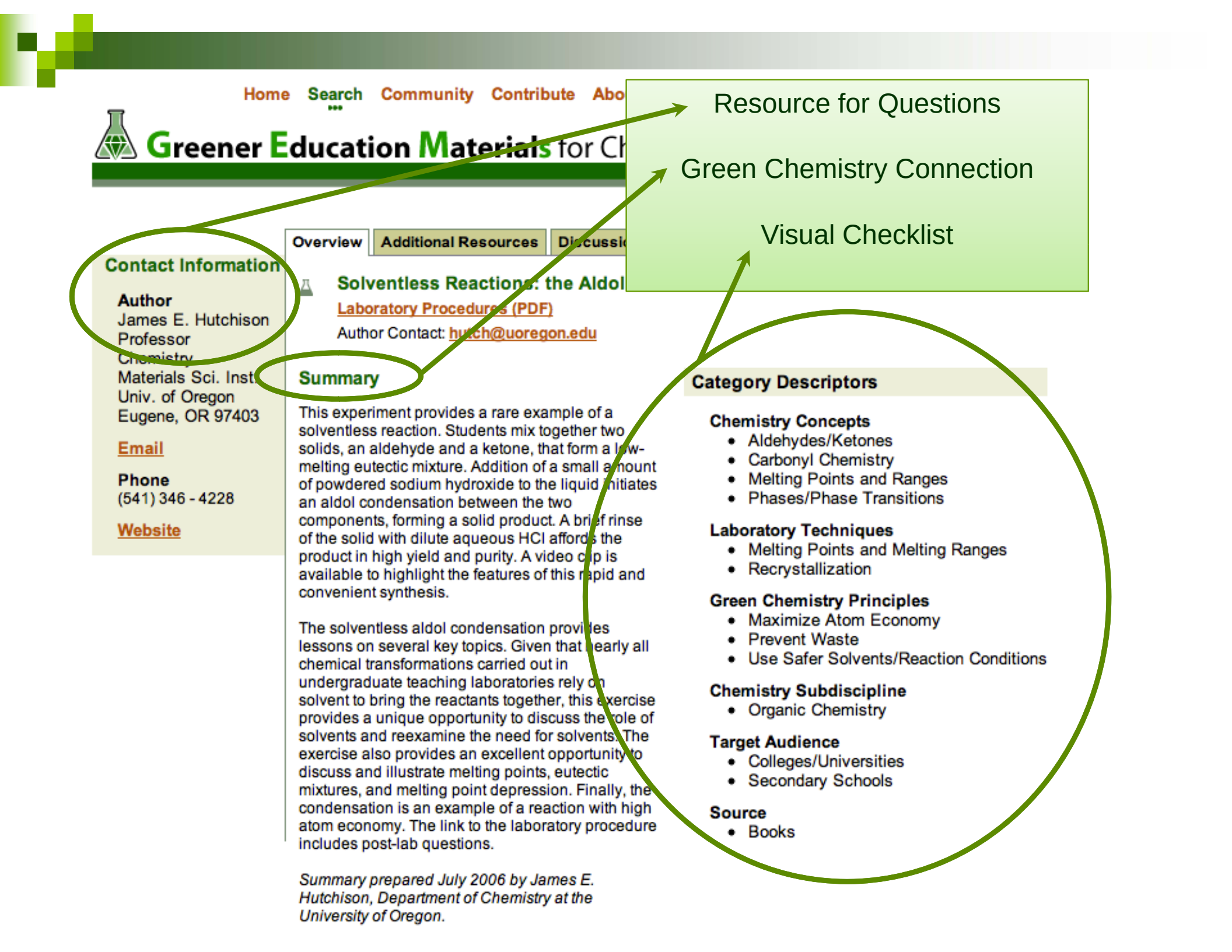
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Ideas for Implementation
Assessment Materials
Demonstrations and Classroom Activities
Links to Related Resources

open source - contributed by the community

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Assist with content choice
Communicate tips for adoption
and lab enhancements

Provide personal contacts necessary for the collaborative development of new materials

open source - contributed by the community

Connections Enrich the Curriculum

Communities Support Transformation

Green Chemistry Education Network

Mission

to advance the principles of green chemistry by supporting a global network of science educators who research, develop, implement and disseminate green chemistry education materials.

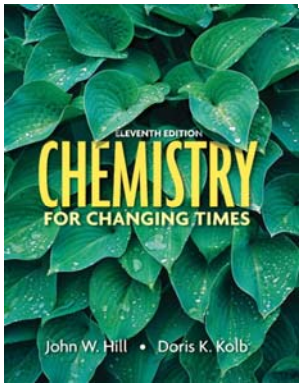
GCEdNet™

http://greenchem.uoregon.edu

Textbooks Transform Perception

Opportunities

- Promote green chemistry to general audiences
- First to integrate green chemistry throughout the text
- Engage leading green chemistry educators from all over the U.S.A.



Chemistry for Changing Times, 11th edition by John W. Hill and Doris K. Kolb
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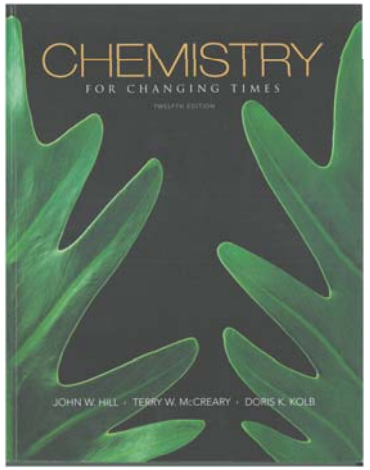
Impacts

- Rapid development 19 new educational materials including models for incorporation (context and level)
- Dramatically increase exposure of gc to new audiences
- A new model for materials development
- Legitimized green chemistry as a significant component of the course material
- Inspired healthy competition in the market



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Innovative Workshops Facilitate Diffusion

Liquid CO_2 Extraction

Solventless Reactions

Cups to Cleaners PLA

Greener Synthesis Creatine

Measuring Ecotoxicity

Biodiesel

Design Features

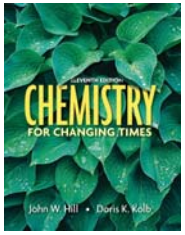
- Short workshop (3 hours)
- Multiple lab exercises (5-6)
- Core material appropriate for multiple learning environments
- Facilitate networking

Impacts

- Delivered at a national meeting (BCCE 2008)
- Materials form the foundation for regional workshops
- Expanded the context for adoption

Acknowledgements

GEMs Database
Past participants of the Green Chemistry in Education Workshop (2001-2010)
Jim Hutchison, Ken Doxsee (University of Oregon)
Dana Garves (UofO)
UO Center for Education Technologies
Robert Albano (UofO)
National Science Foundation



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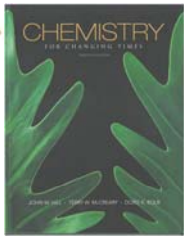

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Summer Lab Workshop #1

GEMs 1.0

Google Map

Capacity Building Workshop

GEMs 2.0

Impact Study

2001 **2005** **2006** **2007** **2008** **2009** **2010**

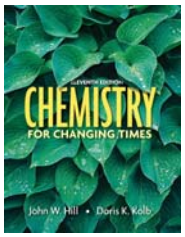
Acknowledgements

Textbook Project

Prentice Hall

Paul Anastas, Kathryn Parent, Jennifer Young (ACS - Green Chemistry Institute)

Contributing Authors (15-20 per textbook edition)



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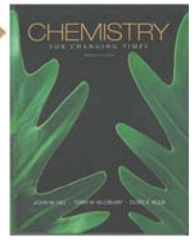

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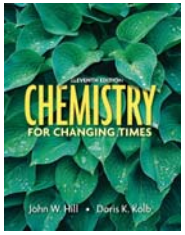
Massachusetts (7)
Minnesota (2)
Oregon (5)

ACS – GCI (1)



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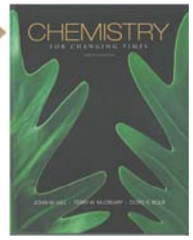

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