Cultivating Next Generation Solutions

greenUp

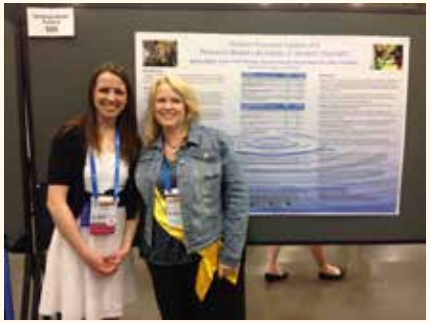
Kellogg Center, Michigan State University
East Lansing, Michigan

Deanna Cullen

- Chemistry Teacher, Whitehall High School, Whitehall, MI
- *Journal of Chemical Education* Associate Editor Precollege
- *Chemical Education Xchange* Associate Editor, www.ChemEdX.org
- @CullenChemEdX OR @ChemEdX

Who am I?

Whitehall High School, Whitehall, MI



class
of
1984

20 Years of Service

My Green Chemistry Journey

- Partnered with GVSU and the Michigan Green Chemistry Clearinghouse project
- Beyond Benign training (2013)
- Presentations
  - GVSU GreenUp 2013
  - GVSU Fall Science Update meeting 2013
  - MSTA 2014
  - GVSU BCCE 2014

GRAND VALLEY STATE UNIVERSITY

MICHIGAN GREEN CHEMISTRY CLEARINGHOUSE

What is this Green Chemistry?

- Green chemistry is the science of designing safer products and processes for a more sustainable future.

- Pro-active, *innovative* science which *targets pollution prevention at the source*, stopping or reducing waste before it even begins.

Program Goals

- Increase awareness in K-12 education
- Form communities of interested teachers
- Encourage collaboration to develop green chemistry curriculum.
- Discuss how green chemistry concepts relate to the NGSS: Next Generation Science Standards

Green Chemistry in the High School: Lessons from Beyond Benign

"For Teachers, By Teachers"

The High School level Green Chemistry lesson plans from Beyond Benign are designed to give teachers the tools to both do and teach green chemistry in their classrooms. The lessons are divided in to three sections, each of which is listed below.

Teachers who wish to infuse Green Chemistry into a regular Chemistry course at the high school level should use the "Curriculum Mapping" document to augment their established curriculum and replace laboratory activities that use and teach techniques and materials that are hazardous to human health and the environment. The topic areas are those typically included in a high school introductory chemistry course.

- Curriculum Mapping PDF
- Intro to GC for Teachers PDF
- Intro to GC Principles Presentation PDF

- Intro to GC Biomimicry DOCX
- Intro to Biomimicry Picture Set PDF

Green Chemistry Online Course for Educators

Green Chemistry is the science of creating safe, energy efficient and non-toxic products and processes and offers a concrete path towards solving the environmental problems our society faces today.

This course begins with an introduction to the 12 principles of green chemistry and then concentrates on the exploration and creation of green chemistry lesson plan materials. Educational resources that are proven vehicles for bringing green chemistry concepts to high school students will be introduced. These lesson plans are designed to integrate into current curriculum and meet national education standards in science and connecting disciplines.

The materials are designed for high-tech, low-tech and no-tech implementation so that teachers with varying resources have an avenue for implementation.

- Course Details
- 2014 Summer Flyer [PDF]

John Warner "Intellectual Ecology" Part 1 from Bioneers

NGSS Connections

HS-ETS1-3 Engineering Design
Students who demonstrate understanding can:
HS-ETS1-3.Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

HS-ESS3-2 Earth and Human Activity
Students who demonstrate understanding can:
HS-ESS3-2.Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

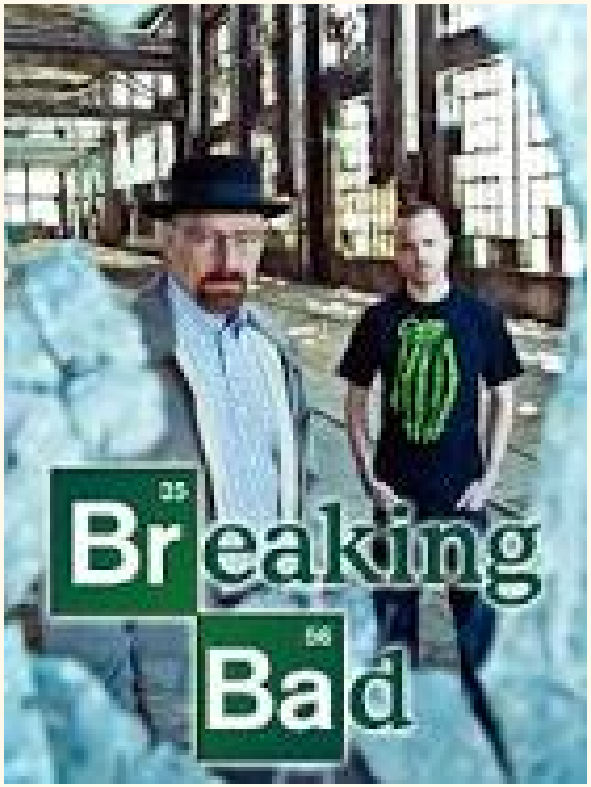
NGSS

1 Scientific and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

What Do Chemists Do?

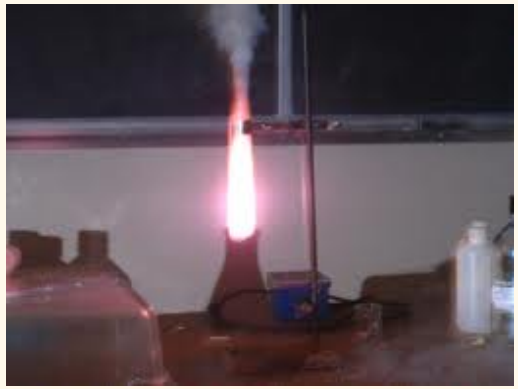
POLLUTION



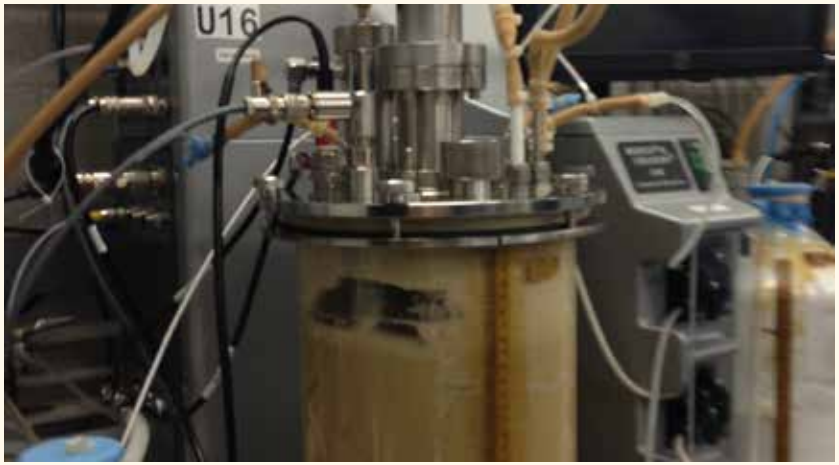
WASTE

ENVIRONMENTAL DAMAGE

This is What My Students Ask For…



How To Change Those Perceptions



Green Chemistry Replacement Labs

- Catalysts and Oxygen

$$2\ H_2O_{2\ (g)} \text{ à } 2\ H_2O_{(g)} + O_{2\ (g)}$$

- Endothermic and Exothermic Reactions

Everyday chemicals allow students to make more connections between their lives and chemistry AND they are safer and more friendly to the environment.

Equilibrium/ Le Chatelier's Principle

Iodine + starch D Starch-Iodine complex

(colorless) (blue-black)

Replacement Lab using less toxic alternatives than some commonly used.

Tea + H^+ ß à $TeaH^+$

dark color light color

JCE Classroom Activity #105: A Sticky Situation

- SOLUBILITY
- INTERMOLECULAR FORCES
- POLARITY

Classroom Activity #105: A Sticky Situation
J. Chem. Educ., **2010**, *87* (4), pp 396–397

Sugar & Sulfuric Acid Replacement Demonstration

- Add a small amount of yeast to some 3% hydrogen peroxide and measure the temperature change over time.
- Introduce reactants vs. products, decomposition reactions, exothermic reactions and catalysts.

$$2H_2O_{2(l)} \rightarrow 2H_2O_{(l)} + O_{2\,(g)}$$

http://www.chemedx.org/video/dehydration-sucrose-sulfuric-acid

Sometimes “Watching” is Better

Nail Bottle Demonstration in Slow Motion

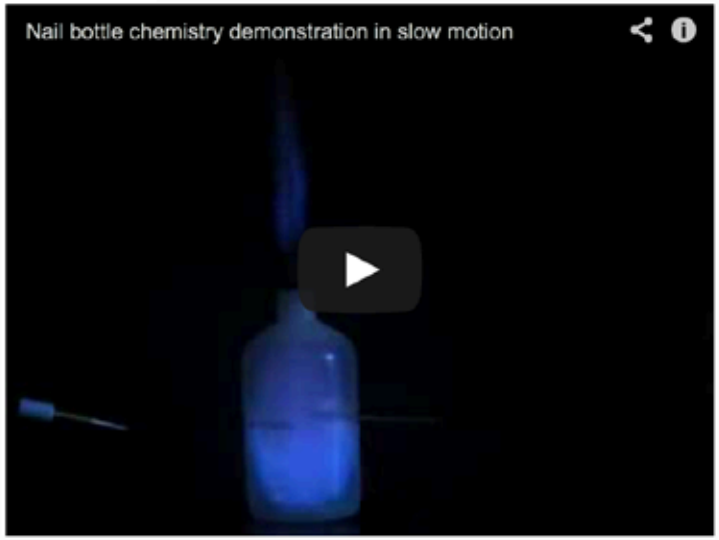
View | Edit | Track | Log

FRI, 02/21/2014 - 12:27 -- TOM KUNTZLEMAN

The nail bottle demonstration[1] is one that many of us have conducted in our classes. To perform this demonstration, 2 – 3 mL of ethanol is placed into a plastic bottle that has two nails punctured into opposite sides of the bottle. After stoppering the bottle, a Tesla coil is touched to one of the nails. A spark jumps from one nail to the other, which initiates the combustion of vaporized ethanol inside the bottle:

$$C_2H_5OH(g) + 3\,O_2(g) \rightarrow 2\,CO_2(g) + 3\,H_2O(g)$$

We recently filmed this reaction with our high speed video camera:



Including Green Chemistry in HS Curriculum~ (Even if you don't have room for it)

- Be intentional and open about safety and conservation.
- Discuss where specific chemicals come from, safety concerns and disposal issues.
- Choose "greener" household chemicals when possible. Discuss the chemicals you are replacing.
- Discuss "Green Chemistry" Careers
- Modified Labs / Replacement Labs

ACS

Chemistry for Life™

VISION – Improving people's lives through the transforming power of chemistry.

ACS Green Chemistry Institute®

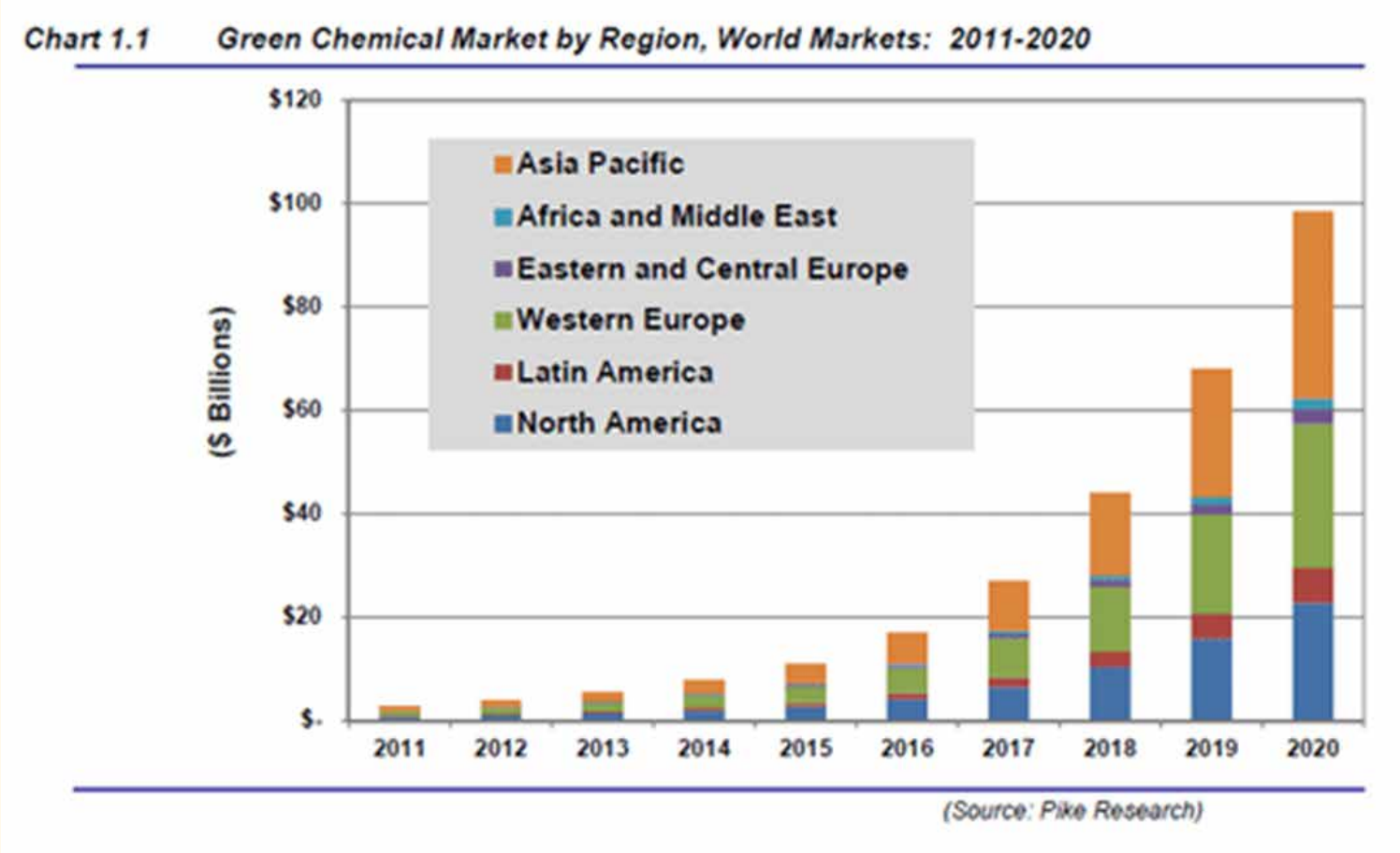
AACT™

American Association of Chemistry Teachers

ACS High School Chemistry Guidelines and Recommendations

- "Chemistry teachers should make conscious decisions to limit the negative environmental impact in the design and enactment of their curriculum. They should model environmentally responsible actions for their students."

Green Chemistry Market Growth=Job Opportunities for Students



CHEM ED XCHANGE

Division of Chemical Education, Inc. of the American Chemical Society

CHEM ED XCHANGE

Search Che

HOME LEARN SHARE VIDEO ABOUT

Home » Blogs » Deanna Cullen's blog

Green Chemistry

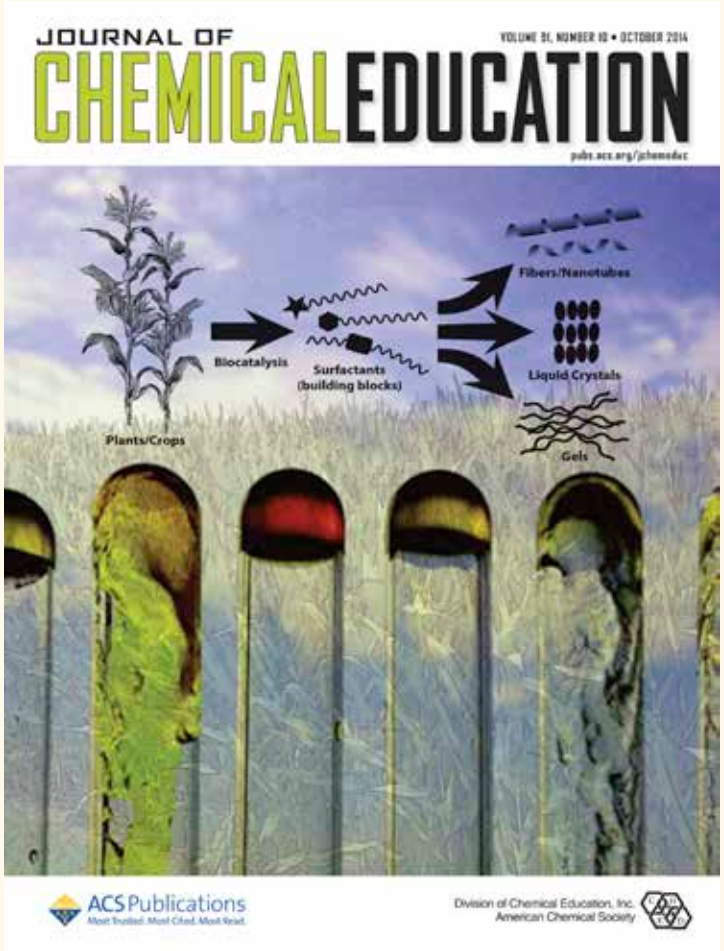
View Edit Track Log

FRI, 11/08/2013 - 12:25 -- DEANNA CULLEN

This past summer, I took part in an online professional development offered by **Beyond Benign**. According to the Web site, "Beyond Benign was created by Dr. John Warner, a founder of the field of Green Chemistry, to provide an approach and means for scientists, particularly those involved in green chemistry and sustainable science, to reach out to the public." I learned a great deal from the training. I was exposed to many resources that I did not know existed. I found lessons that I can easily incorporate into my curriculum that make a connection between the student and the chemistry content. Nothing is more powerful in a chemistry classroom than when a student can identify how the course content affects their everyday life and their future.

The course introduces the **Twelve Principles of Green Chemistry** and then introduces teachers to the wealth of resources available that provide real world connections, provide safer and more environmentally favorable alternatives to common chemistry laboratories and demonstrate the effects of chemistry on our world. The Beyond Benign Web site offers the following definition for Green Chemistry: "**Green Chemistry** is the science of creating safe, energy efficient and non-toxic products and processes and offers a concrete path toward solving the

www.ChemEdX.org



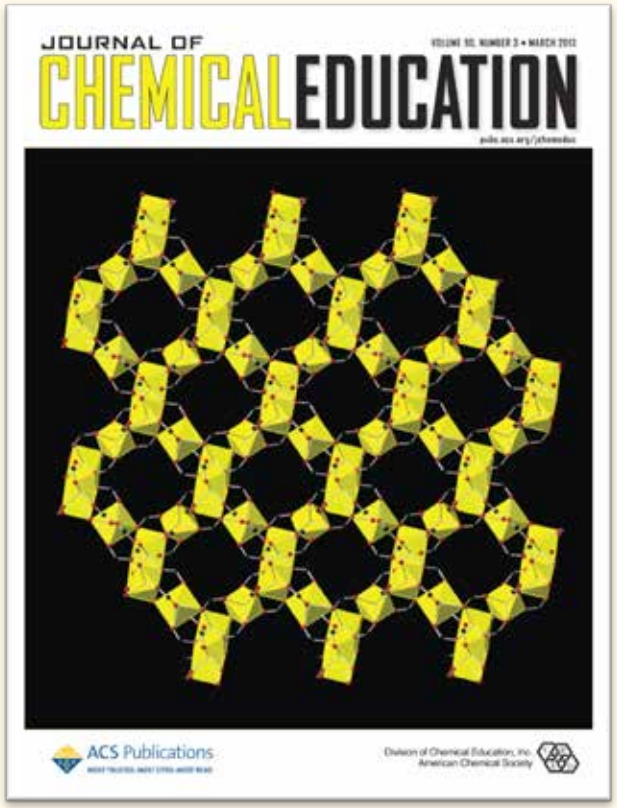
"Sweet and Sustainable: Teaching the Biorefinery Concept through Biobased Gelator Synthesis" (DOI: 10.1021/ed3007764), Hyeondo Luke Hwang, Swapnil Rohidas Jadhav, Julian Robert Silverman, and George John..

Advanced Placement Chemistry
Special Issue

CHEM ED XCHANGE

Deanna Cullen
Associate Editor Precollege
Journal of Chemical Education
dcullen@jce.acs.org
231-730-0004
: @CullenChemEdX

www.ChemEdX.org



National Chemistry Week 2014 –
The Sweet Side of Chemistry-Candy
(Showcasing the chemistry involved in candy and confections).

October 19 – 25, 2014

ACS Publications
MOST TRUSTED. MOST CITED. MOST READ.

The World's Premier Chemical Education Journal

- **Written by teachers, for teachers.**
- **For chemical educators** from elementary and middle school through college and graduate school.
- **Your resource** for peer-reviewed articles, news, commentary, reports, columns, laboratory and classroom activities.
- **Reputation for Excellence** with ACS Publications and the ACS Division of Chemical Education.
- **No Publication Charges** for authors.

pubs.acs.org/jce

Associate Editor Precollege:
Greg Rushton and Deanna Cullen