Research-based instructional strategies in a course on the role of chemistry in solving global challenges

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CHEM 341 - Global challenges: A chemical perspective

- **Department of Chemistry offering to the Combined Major in Science (CMS) program since 2011/12**
- **~160 students; ~60% CMS, 20% Chem. Majors, and 20% other Majors**
- **Examples of course objectives**

By the end of this course, students should be able to:

2. Express in written and oral form why chemistry and chemical research is important in society.

4. Converse enthusiastically with friends and family about the role of chemistry in addressing the global challenges facing the human race.

5. See the connection between the content of their undergraduate chemistry courses and global issues.

6. Spontaneously seek out chemical inconsistencies and inaccuracies and begin to form their own opinion when reading or watching news reports...

9. Work effectively as a member of a team of scientists.

Overview of activities

- Restructuring of class time to create increased opportunities for discussion and feedback
- Implementation of two-stage exams and exam wrappers
- Replacement of final written assignment with a term-long team research project to create increased opportunities for feedback and for developing science communication and teamwork skills

Restructuring of class time

Typically...

1. Reading and guiding questions/tasks to be completed ahead of class
2. In-class peer discussion activities based on pre-class preparation
3. Whole class discussion on topic guided by instructor

In-class interactive activities included:

whole class jigsaw activities

small-group discussions

concept mapping

decision tasks

worksheets

compare/contrast framing

Implementation of two-stage exams and exam wrappers

- Three midterms replaced with two-stage exams; implementation as described by Gilley and Clarkston,[1] but with a twist…
- "Bonus credit" available during group part if team is able to offer additional examples/details on open-ended questions
- Generated high levels of engagement; teams eager to show what they know
- In-class "exam wrapper" exercises following exams[2]

[1]B. H. Gilley and B. Clarkston, *Journal of College Science Teaching,* 2014, **43**, 83; [2]M. C. Lovett, in *Using Reflection and Metacognition to Improve Student Learning*, ed. by M. Kaplan *et al*. (Stylus Publishing, Sterling, Virginia, 2013)

Term-long team research project

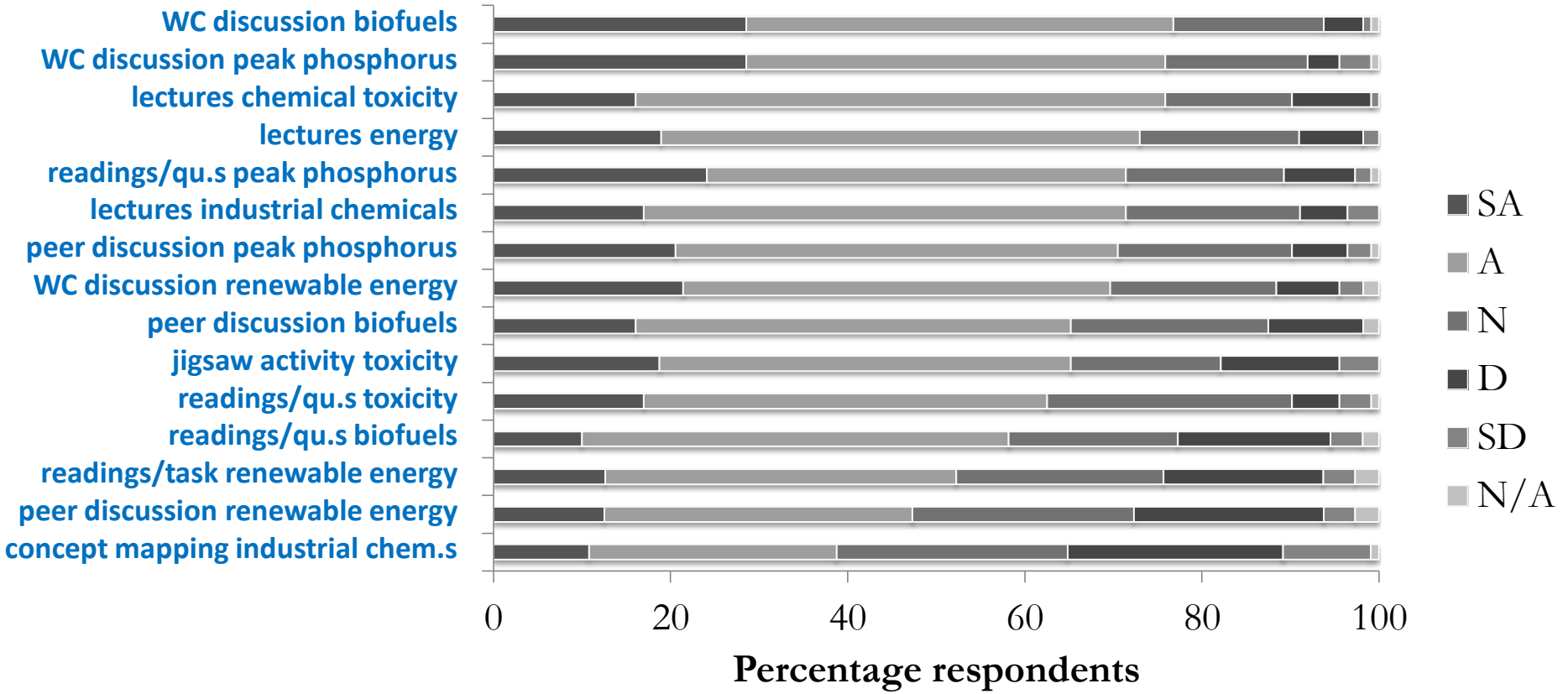
In teams, students research and analyze a global challenge from a chemical perspective; culminating in a conference-style poster session

Features:

- Term-long project, with deliverables throughout
- Individual phase and transition to team phase
- Individual and group peer-review processes
- Opportunities to revise work in light of feedback
- Structured practice in teamwork (group contracts, feedback from team members *via* iPeer)

Student perceptions of course (midterm survey)

Learning activities:
"… was helpful for developing my understanding of this topic"



Student perceptions of course (midterm survey)

List the one or two aspects of this course that are most helpful for your learning:

Student perceptions of course (midterm survey)

List the… aspects of this course that are most helpful for your learning

"The topics chosen are very interesting and relevant to our current society and the discussions in class help me think and argue my perspective on the issue."

"Being able to read articles relating to the topic and discussing them in class helps my learning the most. This helps me retain information the best and also helps improve my critical thinking skills."

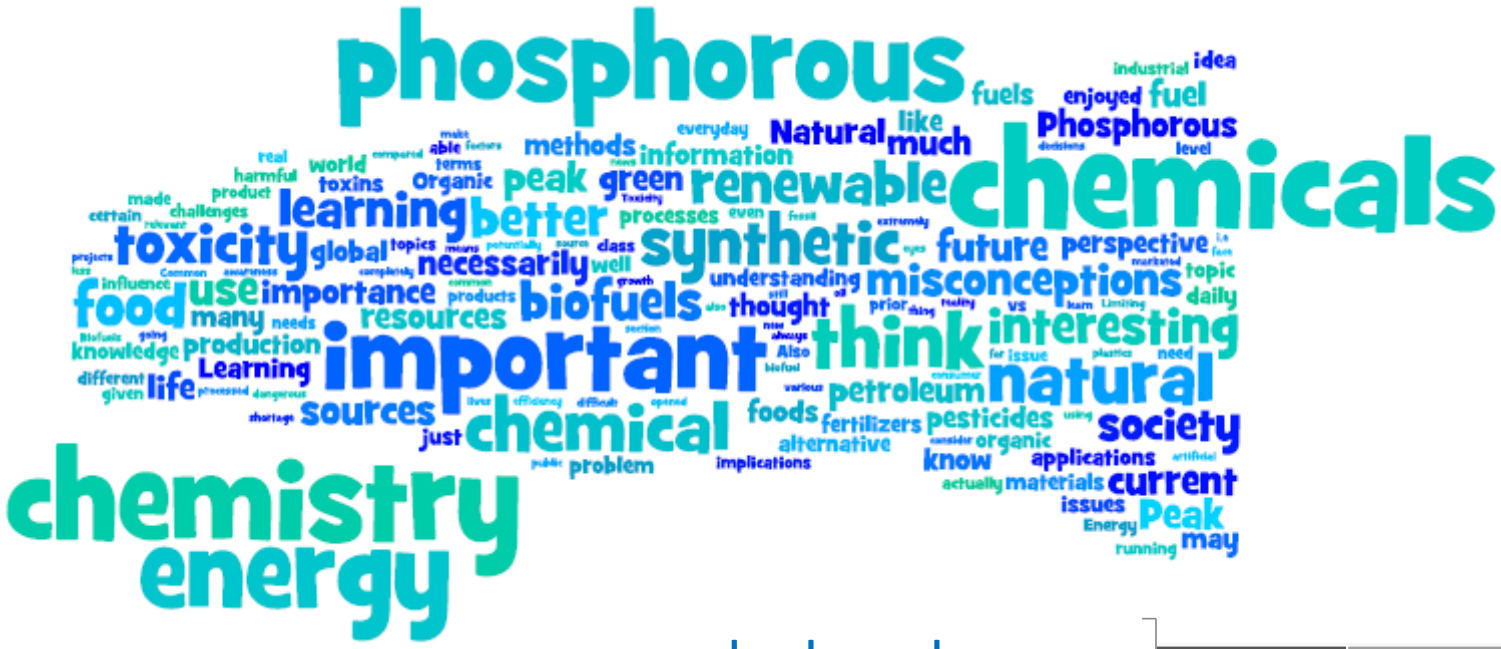
"I find I retain the most information from interactive activities, such as those when we are given readings or told in advance to think about a particular topic, given group time to discuss or work on a worksheet, and then Prof. reviews the important concepts in a lecture-style format. Whenever there are worksheets my learning seems to be the most noticeable."

"Collaborating on group assignments forced me try harder in an attempt to preserve my ego."

"i just appreciate how there's reading and it doesn't simply stop there. The discussions we have in class clarify and address the areas I need to focus. This way, I'm not wasting my time trying to understand what may not be as important"

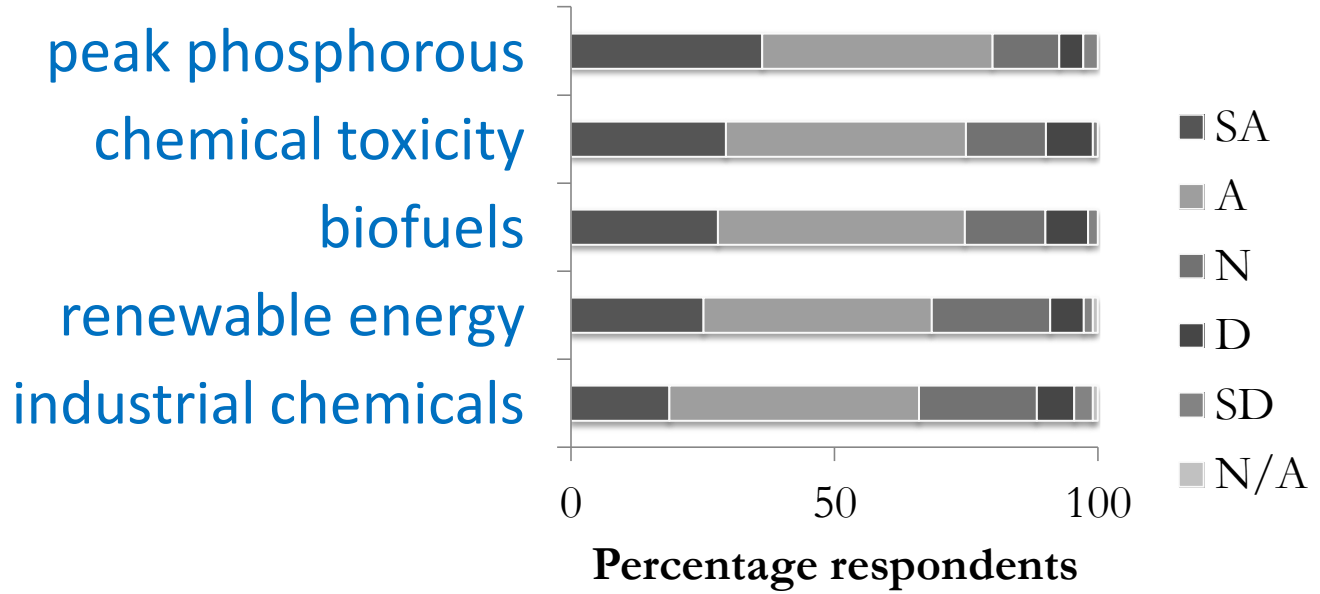
"1) Innovative topics. 2) Interactive class activities."

Student perceptions of course (midterm survey)



"Describe the (most important things) you have learned..."

"I think differently about (this topic) as a result of (this course)"



Student perceptions of course (midterm survey)

Describe the one or two most important things you have learned…

"I learned about the peak phosphorus which I believe will be a very huge issue very soon and I learned about how chemistry really does cover many aspect of our lives."

"I actually really like this course. I feel like for once i have learned things in science that are so direct to todays problem/challenges/great discoveries."

"The first two topics were very relevant to society, and my life, cleared up some misconceptions I had , as well as common misconceptions."

"2.We're a lazy, wasteful, environment-destroying, ignorant species that are planting the seeds of our own eventual demise, and a majority of us don't even know it. But hey, at least this class is trying to do something about it!"

"I think that the societal factors that we consider, whether it be the phosphorus shortage, or the implications of bio-fuels, are extremely interesting and hugely important because they are decisions that will need to be made in our lifetime! I was shocked with how unaware and uneducated I was personally on these matters, and I think it is important to learn about these things because they are going to have a drastic influence on both my own future as well as upcoming generations."

Future directions

Pre- and post- measures collected:

- Attitudes: Subset of CLASS[1] subscales and SPESS[2] 'Science and Society' and 'Human-Science Interaction' subscales adapted for chemistry
- Confidence in chemistry: ITOI scale items adapted for chemistry
- Interest in topics; changed thinking about topics (self-reports)

Post- measures collected:

- SALG-style items with respect to helpfulness of course offerings
- SALG-style items with respect to high-level learning objectives

Other plans:

- Use examples of student work to investigate use of peer feedback
- Workshop at Improving University Teaching Conference 2014[3]

[1]J. Barbera *et al*., *Journal of Chemical Education*, 2008, **85**, 1435A; [2]Jolley *et al*., *Journal of Geoscience Education*, 2012, **60**, 83; [3]K. J. Knox, B. Gilley and T. Ivanochko, Research-based instructional strategies for fostering behavioral change, interactive workshop, IUT Conference, Vancouver, Canada, July 2014

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