Qualitative Analysis of Student Experiences in Novel Multi-Year CURE Curriculum

Madalyn Hymowitz, Emily Fitzpatrick, Emily Rennells,
Dr. Eric Helms, Dr. Michael Webb and Dr. Jeffrey Peterson
Dept. of Chemistry, SUNY Geneseo, Geneseo NY 14454

Introduction

CUREs:

What are CUREs?

- Course-Based Undergraduate Research Experiences (CUREs) are a laboratory pedagogy in which students complete authentic research projects rather than traditional expository experiments.

Why implement a CURE curriculum?

- Intended to broaden access to research for all students and for them to gain experience in multiple fields, instrumentation, techniques, and reporting data.
- Benefits are included for students and professors with examples such as an increase in graduation rates for STEM degrees and an increase in publications.

How do CUREs work?

- There are five hypothesized elements of CUREs that make them effective:
  - Project Ownership
  - Mentorship
  - Collaboration
  - Iteration
  - Relevance/Discovery

Primary Research Question: What are student perspectives on a novel chemistry laboratory CURE curriculum?

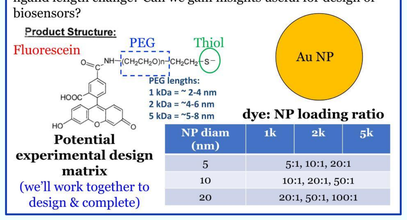
- Most CUREs reported to date are one-semester, stand-alone experiences.
- A novel CURE curriculum was implemented at SUNY Geneseo that spans multiple years and subdisciplines of chemistry.

Curriculum Design and Project Descriptions

	First Year	Second Year	Third Year	Fourth Year
Fall	**CHEM 119** Introductory Chemistry Lab	**CHEM 216** Organic Chemistry Lab	**CHEM 331** Lab Techniques in Inorganic Chemistry	**CHEM 401** Senior Capstone Research
Spring	**CHEM 209** Intermediate Chemistry Lab	**CHEM 313** Lab Techniques in Organic Chemistry	**CHEM 342** Modern Analytical Chemistry Lab	**CHEM 301** Biochemistry Lab **CHEM 361** Modern Chemistry Lab

CHEM 209: Fluorescence Quenching in a Model Biosensing System

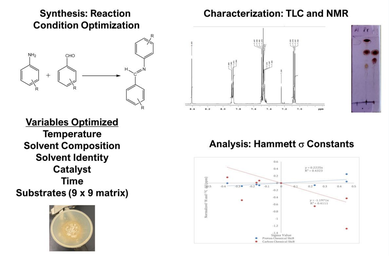
Basic Research Question: How does quenching of dye molecule change as loading ratio(# dye per NP), NP size, and ligand length change? Can we gain insights useful for design of biosensors?



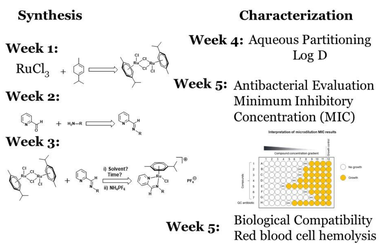
Potential experimental design matrix
(we'll work together to design & complete)

NP diam (nm)	1k	2k	5k
5	5:1, 10:1, 20:1		
10	10:1, 20:1, 50:1		
20	20:1, 50:1, 100:1		

CHEM 313 CURE: Optimizing the Green Synthesis of Imines



CHEM 331 CURE: Ruthenium-based Antibacterial Agents



CHEM 401 CHOOSE YOUR OWN ADVENTURE®

There were 3 faculty instructors to oversee student research projects:

- Synthesis and Lateral Growth Analysis of CdSe NPLs
- Green Synthesis of Maleimides
- Screening for small molecule inhibitors of Spike-ACE2 binding
- Synthesis and Evaluation of Ruthenium complexes for antibacterial activity

References
Auchincloss et al., Assessment of Course-Based Undergraduate Research Experiences: A Meeting Report, 2014
Burgin et al., 2012, 2014
Corwin et al., The Laboratory Course Assessment Survey: A Tool to Measure Three Dimensions of Research Course Design, 2015
Hanauer et al., The Project Ownership Survey: Measuring Differences in Scientific Inquiry Experiences, 2012
Hanauer and Dolan, The Project Ownership Survey: Measuring Differences in Scientific Inquiry Experiences, 2014

Qualitative Analysis of Student Survey

What aspect(s) of the course did you enjoy the most?

Common Themes: Excitement for research: more freedom, learning new techniques, problem solving, collaborating as partners and overall class, preparing for real world and careers

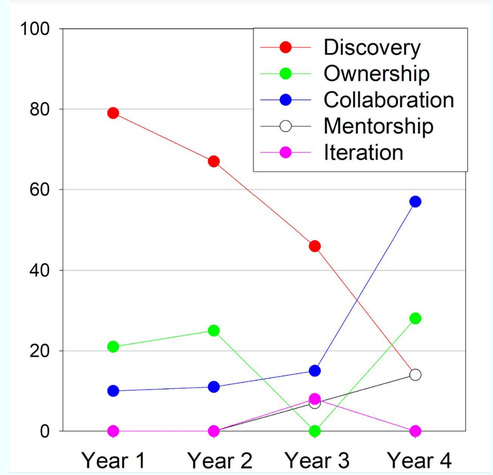
"I most enjoyed isolating products and the excitement of seeing what I had isolated and then characterizing it to determine just what I had made." (CHEM 331, 3rd CURE)

"I enjoyed being faced with problems that I had to try to alter the experiment myself in order to solve, and I felt more satisfaction when getting good data from an experiment I designed." (CHEM 209, 1st CURE)

"*The fact that we weren't graded on arbitrary things, but rather had we learned and gotten through the experiment in one way or another. There wasn't massive penalty for not getting a good result like Chem 119.*"
(CHEM 209, 1st CURE)

"*I liked working with my partner each week and coming up with something to accomplish. I also liked talking to my research professor because he makes it feel like our research is important and very possible to eventually publish.*" (CHEM 401, 4th CURE)

Percentage of Responses Communicating Each CURE Theme



Observations and Conclusions

- During first CURE the main focus was Discovery/Relevance; by the final CURE students were focused on collaboration.
- Students had positive experiences in a multi-year CURE curriculum. One such benefit was self-confidence increased as they progressed through the course sequence.

What aspect(s) of the course did you find the least meaningful or fulfilling?

Common Themes: Preference for research experiments over expository ones; preference for working with a partner; frustration with equipment or procedural issues; dislike for heavier workload

"I didn't have time to reach a satisfying answer to the research question asked." (CHEM 313, 1st CURE)

"Having to write my own lab report. Not super fulfilling but it definitely will help me in the future." (CHEM 209, 1st CURE)

"I found the partner work least meaningful because my partner didn't do anything and I was left with so much work and stress that made this class one of the most stressful for me. I also found it kind of less meaningful that this lab wasn't paired with a class and was very niche and specific which didn't quite draw my interest at times." (CHEM 209, 1st CURE)

What kinds of things were challenging about the lab where the outcome was unknown?

Common Themes: Difficulties with coming up with own procedure, analyzing data, interpreting unclear results, and finishing everything needed for final report within the time frame

"It was harder to figure out if the way that we were doing things was correct or if I was making a big mistake. I constantly felt like I had to backtrack to fix things during research; you didn't know if you were doing something wrong or right, it was mostly on you and your group to say 'yeah I'm definitely doing this correctly'." (CHEM 209, 1st CURE)

"It was hard to decide what the next step should be at some points because there was no predetermined procedure for a lot of it." (CHEM 401, 3rd CURE)

"It was harder to figure out if the way that we were doing things was correct or if I was making a big mistake. I constantly felt like I had to backtrack to fix things during research." (CHEM 209, 1st CURE)

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