

CASPiE Lab Module for Undergraduate Organic Lab

1,intro

Undergraduate Participation in Development and Implementation



Menaka Lunda, Christine Toh, Duncan J. Wardrop, David P. Dickson, and Donald J. Wink

What is CASPiE?



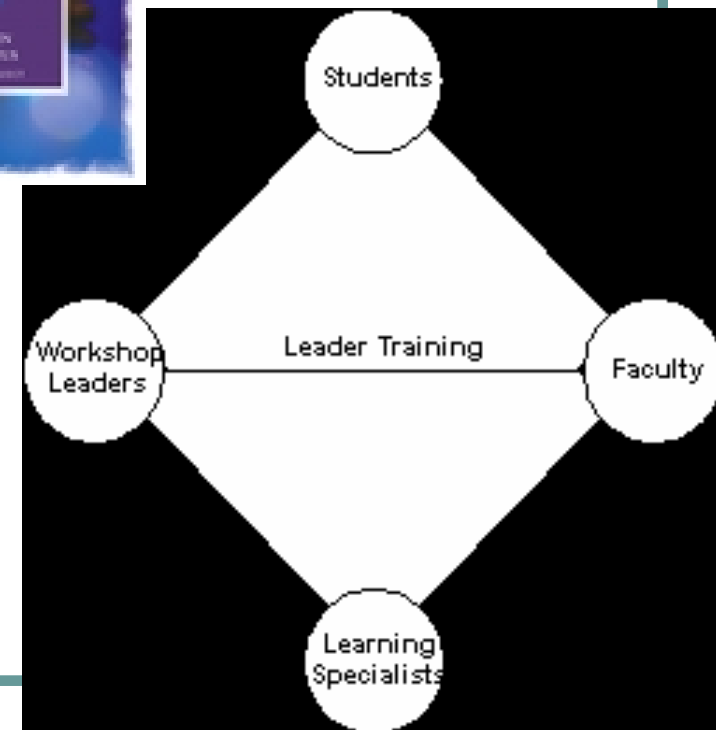
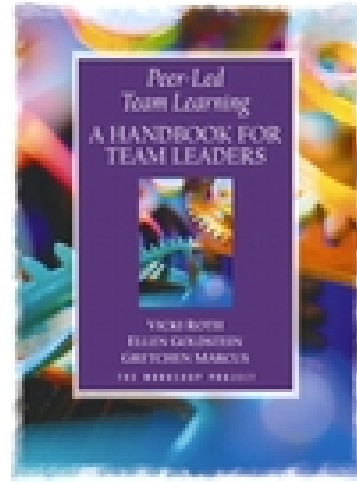
2, intro

- “The **Center for Authentic Science Practice in Education (CASPiE)** is a multi-institutional collaborative effort designed to address major barriers to providing research experiences to younger undergraduate science students.”

<http://www.purdue.edu/dp/caspie/>

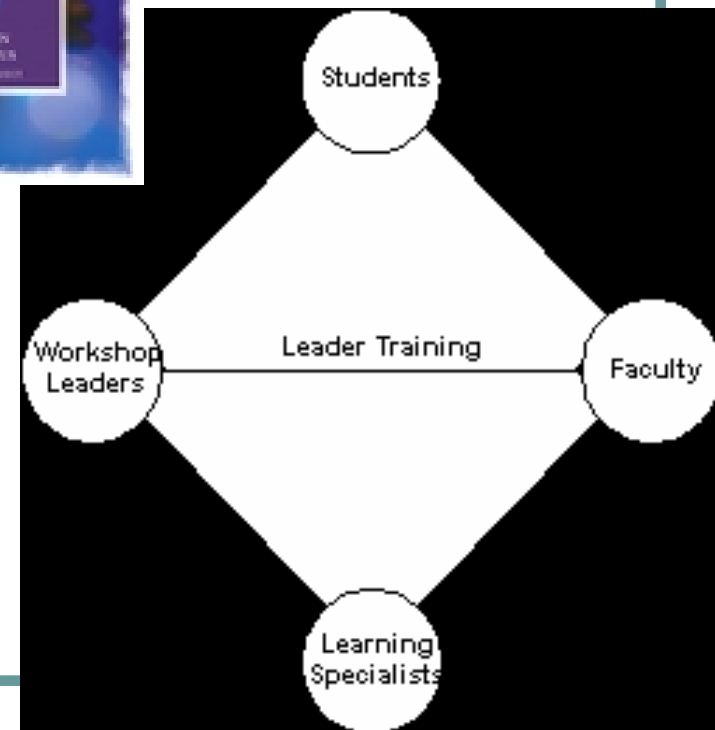
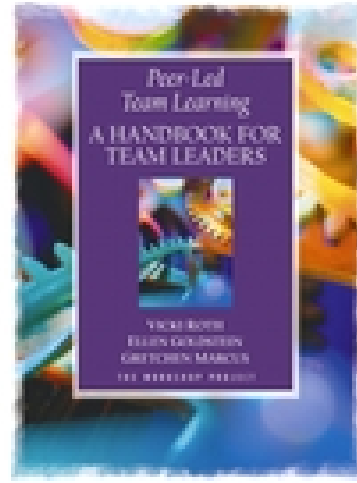
Peer-Led Team Learning (PLTL):

1. A Peer-Led Team Learning Workshop is a regular course component that all students are expected to attend.
2. The faculty teaching the course are closely involved with the workshops and the workshop leaders.
3. The Workshop leaders are well trained and closely supervised, with attention to content knowledge, facilitation and learning techniques.



PLTL, continued:

4. The Workshop materials are challenging, and encourage collaborative problem solving.
5. Organizational arrangements are optimized to promote learning.
6. There is appropriate institutional support for innovative teaching.



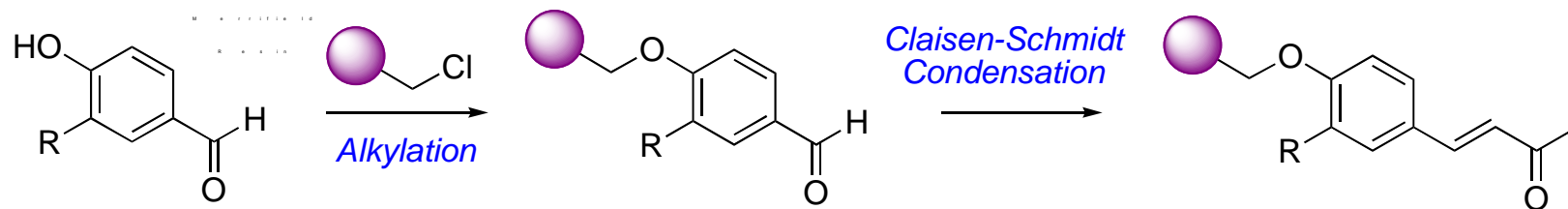
CASPiE and PLTL

- We felt that the PLTL experience also:
 - Provided students with new advanced concepts and scientific opportunities
 - Encouraged students to engage in independent thought and adapt a research “mindset”

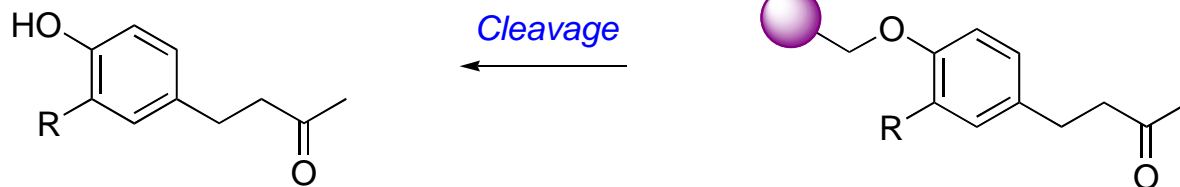
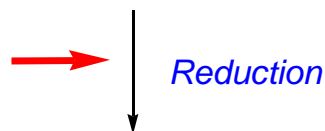
Module Development

- General overview of the module
- Roles of the undergraduate in the module's development
- Overall experience, new skills learned

The Solid-Phase Synthesis Module



Challenge students to discover a reagent that can mediate this difficult transformation

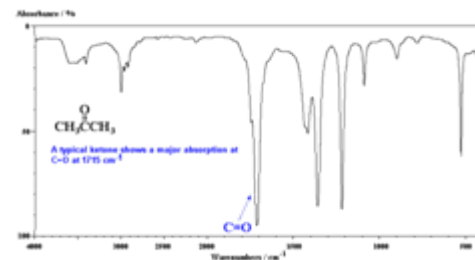
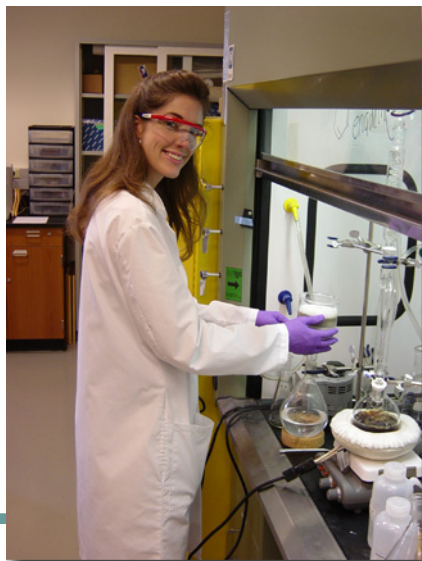
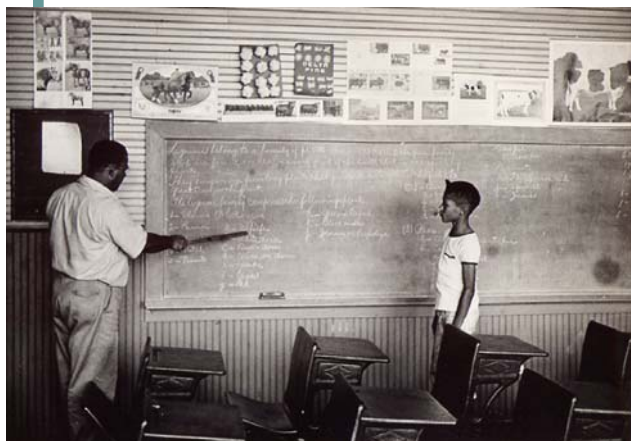


Zingerone (R = OMe)
Rheosmin (R = H)

Roles of the undergrad researchers

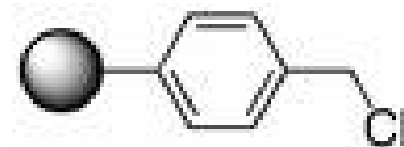
1) Ensure reproducibility:

- Learn techniques from graduate student
- Repeat procedures
- Analyze and compare results

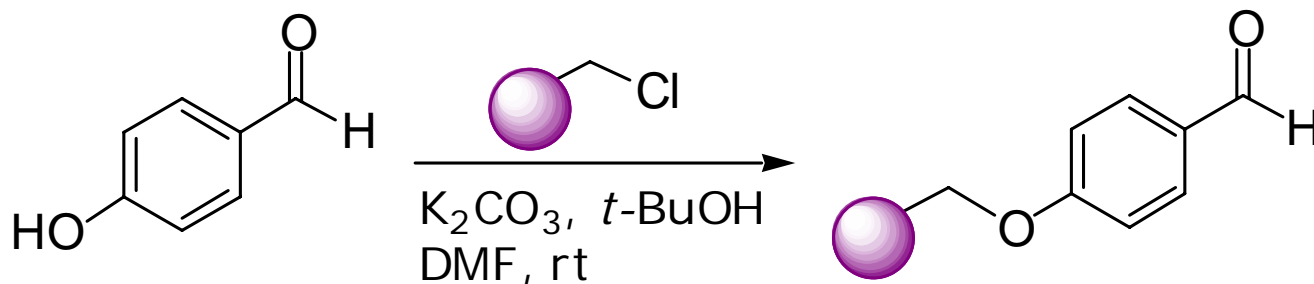


Roles of the undergrad researchers

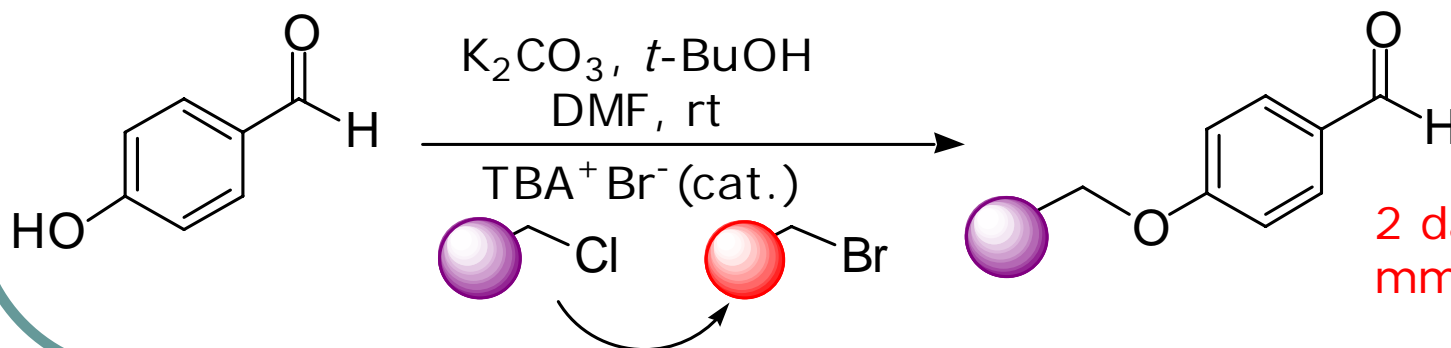
2) Optimize reaction conditions



- Alkylation:



2 days, 0.94 mmol/gram
4 days, 1.77 mmol/gram



2 days, 1.72 mmol/gram

The overall experience

- The research approach
 - Adopting a new mindset
 - Learning how to think about science
 - Getting our feet wet, participating in important work



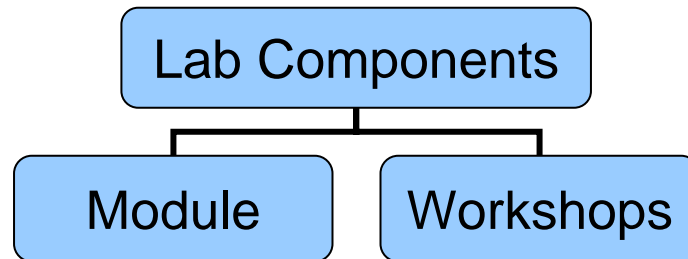
CASPIE: Lab Implementation

1, Implement

- Where in the curricular timeline is the CASPiE module designated?
- How was the CASPiE module presented in the coursework?
- Consists of two parts

CASPIE: Lab Implementation

2, implement

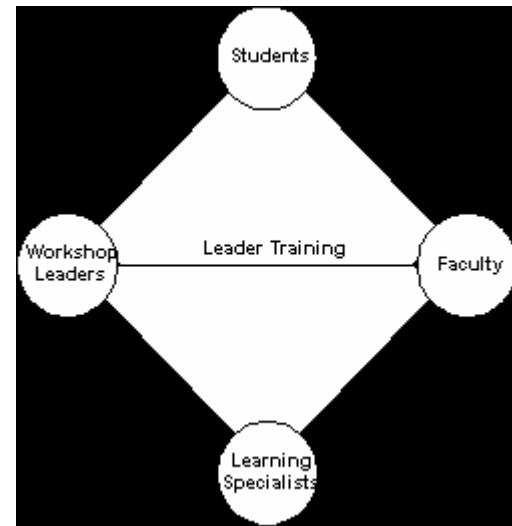


- **Workshop:**
 - Experimental Design
 - Keeping a Lab Notebook
 - Evaluation and Interpretation of Data
 - Reading a Research Paper
 - Ethical Conduct in Science
 - Poster Preparation
 - Writing an Abstract
 - Writing a Scientific Paper

CASPiE: Lab Implementation

4, implement

- The peer-leader-student dynamic prescribes the mutual benefits of debate and discussion
- this innovation is a required activity



CASPiE : Additional Benefits

Last, lab implement

- Problem-solving
- Independent Thought
- Self-reliance
- In Research: Procedures Fail

CASPiE: Module Implementation

1, Module implement

- Research challenges vary per academic cycle
- Hot topic: solid-phase synthesis (Merrifield resin)
- Several reduction methods undertaken
- Parallel experiment: perform same reduction in solution-phase

CASPiE: Module Implementation

4, Module implement

- Upon completing the CASPiE project:
 - Prepare a poster
 - Give an oral presentation on the CASPiE project and results

UIC Undergraduate Participation in the Development of an Organic Chemistry Research Module

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Introduction; What is CASPiE?

- CASPiE, the Center for Authentic Science Practice in Education, is a multi-institutional collaborative effort designed to address major barriers to providing research experience to undergraduate science students.
- This is being done by the development and use of modules for the lab curriculum that have students carrying out genuine research as they teach their peers the concepts and methods of chemistry.

Vision for Undergraduate Research

- Implement modules in undergraduate lab curriculum that give students the opportunity to:
 - Discover new knowledge and develop lab skills in a research group setting.
 - Develop and execute procedures from research literature to tackle an authentic scientific problem.
 - Communicate with researchers, instrumentation and analyze for meaning.
 - Communicate knowledge/results through writing and presentation.

The Peer-Led Team Learning Model

- Peer-Led Team Learning (PLTL): Students form groups of three and work together to complete the module. One Peer Leader is assigned to the groups.
- Who are Peer Leaders?
 - Peer leaders are enthusiastic and motivated students who have completed the module previously and demonstrate good communication and leadership skills. Their role is to:
 - Facilitate group work for the research teams.
 - Lead volunteers that recruit in knowledge and skills necessary for independent research, including using a lab notebook, experimental design, reading a research article, writing an abstract and presentation, poster preparation and ethical conduct in science.

The Undergrad Researchers' Role

The Undergraduate's Role in the Development of the Module:

- Repeat the established procedures to ensure reproducibility.
- Assist in optimization of experimental conditions to make them suitable for an undergraduate teaching lab (i.e. reaction time, hazardous chemicals, equipment).
- Become familiar with the concepts and methods of the module in order to effectively serve as a Peer Leader.

Why Solid-Phase Synthesis?

- The utilization of solid phase chemistry in the drug discovery process has seen explosive growth leading to the development of numerous therapeutic agents.
- Involves immobilization of a molecule onto an insoluble medium followed by a series of transformations. It can be used to generate thousands of compounds, referred to as a library, in an efficient and relatively environmentally benign process.

An Authentic Scientific Problem

- Conditions for chemical transformations in solution phase are not effective when the substrate is attached to a solid support, i.e. hydrogenation using heterogeneous metal catalysts.

Alkylation: the TBAR Effect

Claisen-Schmidt Condensation

CuH: An Effective Reducing Agent

The Sweet Smell of Success!

Analytical Techniques

Implementation of the Module at UIC

- The completed module, entitled "Development of an Old Reagent for the Reduction of Edo-Supported Alkenes: Total Synthesis of Dipeptone and Resipin" (Kosher) was implemented at UIC in two of the three Chem235 Org II Lab sections in Spring 2006.
- Four Peer Leaders selected ten student research teams.
- Students gained experience they otherwise would not have at this level, i.e. solid-phase methods, Ramen spectroscopy, research of scientific literature, poster presentations of new findings.
- Students' responses to PLTL varied but were mostly positive.
- Few groups successfully performed the reduction in the solid phase. Many groups' results were inconclusive.

Results from Chem 235

- Experimental procedures were adapted from literature reports of alkylation reaction in solution phase and attempted on the resin-bound β -unsaturated ketone.

Compound	Yield	Notes
1	0%	One group obtained a mixture of products.
2	0%	Results inconclusive.
3	0%	Results inconclusive.
4	0%	Results inconclusive.
5	0%	Results inconclusive.

Conclusions and Future Plans

What we've done: Developed a solid-phase total synthesis procedure analogous to an undergraduate organic laboratory setting. Addressed a scientific problem: reduction of alkenes for the synthesis of Compendinone analogs (possible anti-cancer agents).

Acknowledgements

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CASPiE: Module Implementation

5, Module implement

- Student response:
 - Anxiety
 - Welcome challenge
 - Indifferent
 - Took some of the intimidation out of teacher-student interaction
 - Concerned with the adaptability of the conditions from the scientific literature

CASPiE: Module Implementation

6, Module implement

- What the experience meant to us:
 - Empowering
 - Encouraging to have input and involvement valued
 - Overcame the challenge of our first teaching experience

Summary/Conclusions

- Undergraduate involvement in module development and implementation:
 - An excellent experience (research, teaching)
 - Skills sharpened (leadership, communication)
 - A lot of fun

Many Thanks

- We are grateful for:
 - Dr. Wink, for the CASPiE opportunities
 - David Dickson, graduate student
 - Dr. Wardrop, our research advisor at UIC
 - All the folks involved in CASPiE
 - The generous support from the National Science Foundation for CASPiE nationwide

CASPiE: Acknowledgements

3, conclusion

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CASPiE: Goals



- **Goals of CASPiE:**

1. Introduce students to advanced concepts in research early on in their undergraduate career.

- Modules contain an authentic scientific problem and employ techniques new to students
- Students learn the value of search engines (i.e. SciFinder)
- Organic Chemistry Module developed for implementation into the 2nd semester undergraduate Organic Lab

CASPiE: Goals



4, intro

2. Create a collaborative, “research group” environment for students in the laboratory.



- Students work in teams to progress through the module and tackle the research challenge
- Communicate knowledge/results through writing and presentations

CASPiE: Goals

3. Accessibility to the resources of participating institutions within network is provided.

- **Using the Network**

- Students utilize instrumentation essential to experimental research
 - Purdue University: administered virtual Raman spectral analysis
 - Students submit their own samples and acquire spectra/data remotely

