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# Developing a New Model to Provide First- and Second-Year Undergraduates With Chemistry Research Experience: The Center for Authentic Science Practice in Education (CASPiE)

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## A partnership among...

Ball State University

College of DuPage

Harold Washington Community College

Miami University of Ohio

Moraine Valley Community College

Northeastern Illinois University

Olive-Harvey College

Purdue University

State University of New York at Buffalo

University of Illinois, Chicago

Vincennes University

Funded by NSF, Chemistry Division





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To create a renewed interest in the physical sciences by including more **research experiences early** in students' academic careers

Why research?

Why early?



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## National Science Board, *Science and Engineering Indicators* (2002, 2004 and 2006)

- Many undergraduates who initially intend to major in the physical sciences end up changing their majors or not graduating.
- The largest drop out of the physical sciences is between the first and second years
- This drop is larger for women than men, and larger still for underrepresented minorities.



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## Findings about UG Research

### **Gregerman, 1999 and Nagda, et al., 1998**

Students involved in research early in their careers are more likely to...

- stay in college
- get their degrees
- go on to graduate school

### **Seymour, et al., 2004**

Many undergraduates with research experience are reported to have:

- increased sense of confidence in their abilities to do and understand science
- a more positive attitude about science and scientific careers.
- gains in abilities to explain, present, discuss and defend their work

Active engagement in research encourages critical thinking and problem-solving skills, understanding of how to frame research problems, and a clearer understanding of how scientific knowledge is constructed.



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## Models of UG Research

- Students work as part of a scientist's research group
  - Summers or extracurricular during the school-year
  - Research group: scientific community
  - Generation of new knowledge: "authentic"
- Inquiry activities in courses
  - Reach broader student population



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## *Goal*

Introduce an authentic research experience into freshman and sophomore course laboratories in order to increase student retention in the sciences.

- **Increase the numbers of students carrying out traditional undergraduate research.**
- **Help students develop scientific process skills.**
- **Change faculty and student attitudes about what students are capable of.**
- **Increase research capacity at partner institutions through participation in module development and research activities and access to instrumentation.**
- **Contribute to leading-edge scientific research efforts.**



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## *Goal*

Introduce an authentic research experience into freshman and sophomore course laboratories in order to increase student retention in the sciences.

## *Strategy*

Laboratory experiments based on authentic research

***Research Modules***

Access to research-level instrumentation

***Instrumentation Network***

Create a research group / scientific community environment

***Peer-Led Team Learning***



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## Research Modules

- Designed to fit within standard lab schedules
- Developed by a faculty team working together
  - Researcher, Faculty partner from a 2-year or non-research institution, CASPiE staff
- Use materials that are easily available
- Use research-level instrumentation remotely where applicable



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## Modules and Writers

Topic	Author	Inst/Dept	Sem.	Status
biosensors	Albena Ivanisevic	PU/BME	2	✓
antioxidants	Jay Burgess	PU/F&N	2, 3	✓
solid-phase org. synth.	Duncan Wardrop	UIC	3, 4	✓
ZnOx films/solar cells	Kyoung-Shin Choi	PU	2	✓
dairy enzymes	Kirby Hayes	PU/FS	4	editing
biodiesel from waste fats	Veronica Curtis-Palmer, Ana Fraiman	NEIU	3, 4	editing
lipids and health	Bruce Watkins	PU/FS	3, 4	in prep.
drug discovery - antivirals	Don Bergstrom	PU/MCMP	3	in prep.
NO <sub>x</sub> from bio-derived diesel	Ken Brezinsky	UIC/ChEn	3	planned
Soluble nanopolymers for proteomics	Weiguo A. Tao	PU/BioChm	4*	planned

Others being discussed: environmental sci., chemical biology, nanoscience, biotechnology

\*for students in biochemistry department



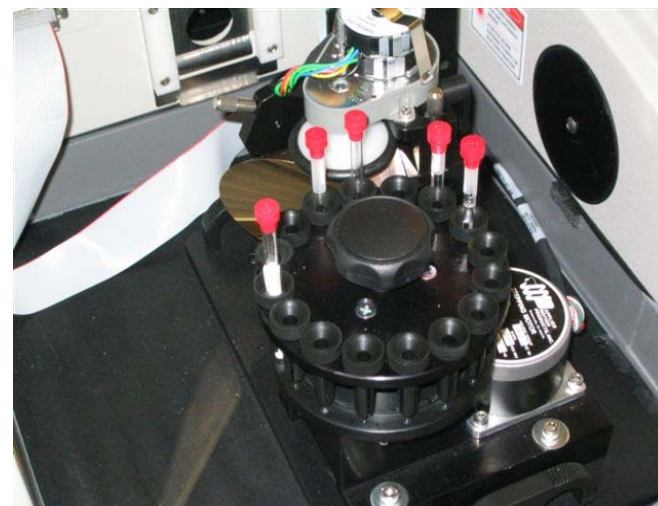
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## The CASPiE Model for Instrumentation

- Research-quality data requires research-quality instrumentation
- High cost → purchase only one of each
  - Equip with autosamplers
  - Enable remote access
  - All institutions can use





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## Instrumentation

- **Current**
  - FTIR/Raman Spectrometer
  - HPLC with Diode Array
  - Gas Chromatograph/Mass Spectrometer
  - Gas Chromatograph
- **Anticipated**
  - FTIR Spectrometer
  - UV-Vis Spectrophotometer
  - NMR

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Experiment: Default - Transmis

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Average  
Statistical Spectra...

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OMNIC - [Window1]

Aromatic Compound

OMNIC Inexperienced Student

Absorbance

Wavenumbers (cm<sup>-1</sup>)

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X: (1908.404) Y: (2.591)

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## PLTL in the Lab – CASPiE Model

- Students work in teams of three in lab – Research Group
- Each peer leader facilitates two teams of three in workshops
- PLTL groups help to create a research group environment





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## PLTL Materials – CASPiE Model

- New workshops have been developed and tested.
- Research-related topics, such as:
  - Research notebook
  - Experimental design
  - Reading a research article



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## Conclusions

Increase interest in the physical sciences by exposing a broad student base to undergraduate research early and through the standard curriculum.

- Research Modules
- Instrumentation Network
- Peer-Led Team Learning



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*Information Technology at Purdue*

*Our partner institutions and collaborators, course instructors and module writers.*



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## Questions?



The Center for Authentic Science Practice in Education  
Home | Instrument Network | Course Materials | Partners | Evaluation | Contact Us

September 16, 2004 - 9:49pm



**The Center for Authentic Science Practice in Education**  
Is it possible to effect a renewed interest in the physical sciences by including more research experiences in the educational process, especially early on when many students are making or adjusting their choice of majors? Can programs be designed that are especially suited to retaining women and minorities as well as other segments of the undergraduate population?

**Overview**

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.

**Our Goals**  
CASPiE will take advantage of the complementary strengths and needs of its different partner institutions to develop a program that will:

1. Provide first and second year students with access to research experiences as part of the mainstream curriculum. Go to: Course Materials
2. Create a collaborative, "research group" environment for students in the laboratory. Go to: PLTL
3. Provide access to advanced instrumentation for all members of the collaborative to be used for undergraduate research experiences. Go to: Instrument Network
4. Help PUI faculty develop research projects to that their own research capacity is enhanced and the students at these institutions can participate in this research. Go to: Partners
5. Create a research experience that is engaging for women and ethnic minorities and appropriate for use at various types of institutions, including those with diverse populations. Go to: Evaluation

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