

# Expanding Research Access and Increasing Student Engagement: Binghamton University's CURE Initiatives

**Megan Fegley**  
Director, First-year Research Immersion



# CURE

(course-based undergraduate research experience)

Defined as having these elements that are reflective of authentic/real research:

- engaging in **scientific process**
- emphasizing **collaboration**
- examining **broadly relevant topics**
- process of **discovery**: exploring questions with unknown answers
- integrating **iteration** into the course

*References:* Auchincloss et al (2014) CBE Life Sci Educ 13(1):29-40; Bangera G, Brownell SE (2014) CBE Life Sci Educ 13(4):602-6; Linn et al. 2015. Science 347: (6222) [doi: 10.1126/science.1261757; Corwin et al (2015) CBE Life Sci Educ 14:es1; Corwin et al. 2015. CBE Life Sci Educ 14:ar37.

# Increased student research access

- Reach more students!
  - Curriculum based
  - One mentor (course instructor) guiding many students
- Explore new research avenues, build data sets
- Trained students continuing research in faculty labs





# Goals for CUREs & CURE Programs

- Increased recruitment **yield** of talented students.
- Increased academic **success** (*satisfaction, GPA, persistence, on-time graduation*) for all students, especially focused on specific populations.
- Increased **personal development** of students at early stage of matriculation. (*confidence, self-efficacy, resilience, identity, community, persistence, goal orientation, connection to their intended discipline*)
- Increased **professional development** and opportunity for students.
- Increased **faculty engagement** and success with undergraduate research.
- **Broaden profile** of students engaged in undergraduate research.
- Demonstrate & catalyze broader **course reform** activities.



# Binghamton's CURE Initiatives

## First-year Research Immersion (FRI)

begins, 90 students/yr

## Summer Research Immersion (SRI)

begins, ~20 students/summer

## Source Project

begins, 75 students/yr

## Source Project

reaches 150 students/yr

Fall  
2014

Summer  
2015

Fall  
2018

Fall  
2019

Fall  
2020

Fall  
2022

FRI reaches, 300 students/yr

**Intro Biology CURE** begins, 850 students/yr

**Gen Chem CURE** begins, 800 students/yr



# First-year Research Immersion (FRI)

- UT Austin's FRI Model
- Began in fall 2014
- University-wide STEM, 300 first-year students enrolled each year
  - 1200+ students have fully completed program to date
- 3 semester sequence of CUREs



# FRI set out to transform STEM educational experience for Binghamton students by giving them an early authentic research experience that would

(a) increase their interest and persistence in STEM majors

(b) improve their ability to meet STEM workforce needs and challenges



# First-Year Research Immersion

## Authentic Research Experience



For students interested in Science & Engineering

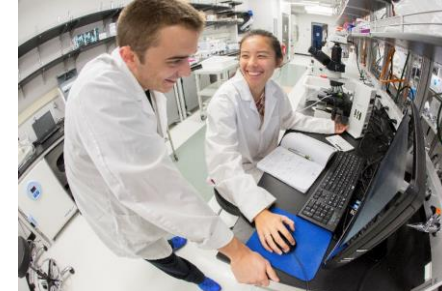
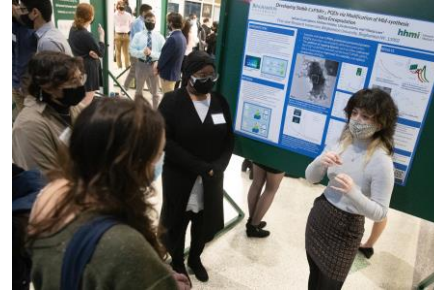
Important real-world research topics

Student-generated research questions

Experimental Design

Discovery

## Career Readiness



Problem-solving skills

Collaboration skills

Communication skills

Leadership

Professionalism



# Overview of FRI Program

## Research Methods Seminar (first-year fall)

- 2 credits
- Oral Communication Gen Ed
- Focus on team project – research question development/pre-proposal
- Public Poster Session

## Research Stream Lab Course #1 (first-year spring)

- 4 credits
- Lab Gen Ed
- Fulfills major requirements
- Conceptual & technical knowledge of research stream
- Develop research proposal

## Research Stream Lab Course #2 (second-year fall)

- 4 credits
- Composition Gen Ed
- Fulfills major requirements
- Conduct research project
- Public poster session

# But why a three-course sequence of CUREs?



Research  
Methods Seminar  
(first-year fall)

Research Stream  
Lab Course #1  
(first-year spring)

Research Stream  
Lab Course #2  
(second-year fall)

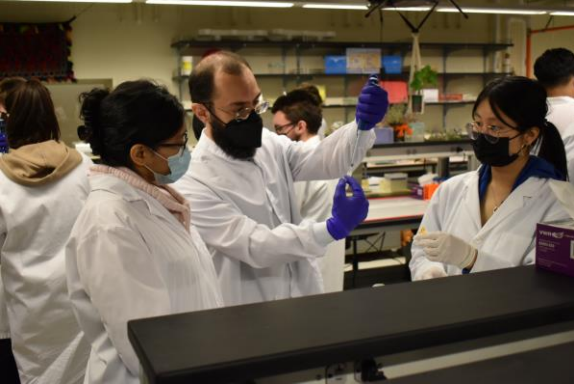


# 10 Research Streams

- Interdisciplinary research themes spanning science and engineering disciplines
- Dedicated lab, research grade equipment & supplies
- Research Educator
- Undergraduate Peer Mentors
- 30 FRI students per cohort
- Team of 3-5 faculty collaborators



# Biological & Health Sciences Research Streams



Biomedical Chemistry

Community & Global Public Health

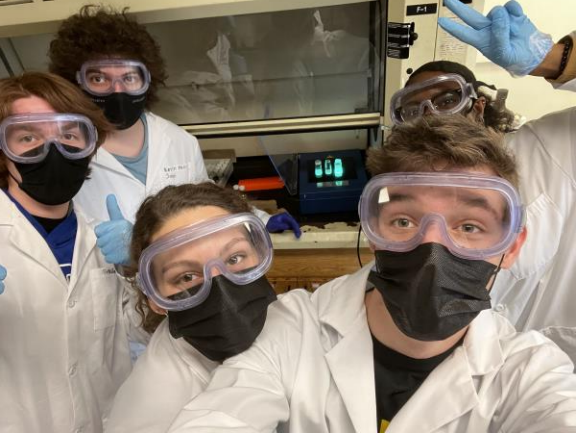
Ecological Genetics

Microbial Biofilms in Human Health

Molecular & Biomedical Anthropology

Neuroscience

# Physical & Applied Sciences Research Streams



**Biogeochemistry** (Environmental Science)

**Environmental Visualization with Drones** (Environmental Studies- Archeology-Geophysics)

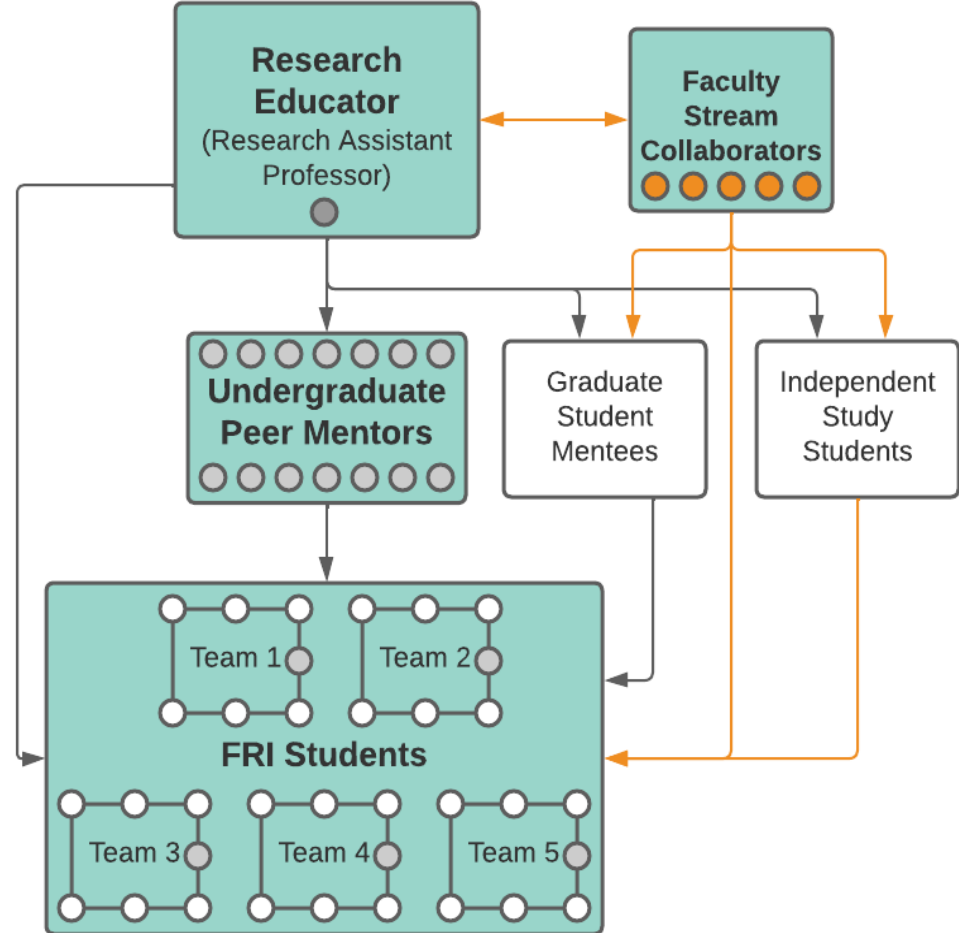
**Clean Energy** (Chemistry-Physics-Engineering)

**Image & Acoustic Signals Analysis** (Electrical Engineering-Computer Science)

# Multi-tiered Mentoring within each Research Stream

## Research Educators

- Lead operations, instruction & mentorship
- Experts in the research discipline of stream
- **Recruitment, training, support, evaluation** and ongoing **professional development** is integral



# FRI RESEARCH EDUCATORS



**Dr. Jonathan Schmitkons**  
Biogeochemistry



**Dr. Susan Flynn**  
Biomedical Chemistry



**Dr. Yancy Luan**  
Clean Energy



**Dr. Christina Baer**  
Ecological Genetics



**Dr. Timothy de Smet**  
Environmental  
Visualization



**Dr. Umur Ciftci**  
Image & Acoustic  
Signals Analysis



**Dr. Cait Light**  
Microbial Biofilms



**Dr. Michel Shamoon-Pour**  
Molecular & Biomedical  
Anthropology



**Dr. Deb Kreiss**  
Neuroscience



**Dr. Jodi Dowthwaite**  
Public Health





# Peer Mentoring

Compensation: course credit  
100-150 peer mentors/semester

## Benefits to program & students

- Building greater sense of community
- Technical & writing support
- Emotional/personal support
- Dedicated team mentor

“give back to FRI community and provide my research knowledge and experience”

“encourage students’ interests in pursuing research”

“develop management and teaching skills to apply to future careers”





## Professional Skills

Teamwork  
Project Management

## Oral Communication

Elevator Talk  
PowerPoint & Poster Presentations

## Scientific Writing

Research Proposals & Manuscripts

## Technical Skills

Instrumentation, Protocols, etc.  
Data analysis

# Student Assessment





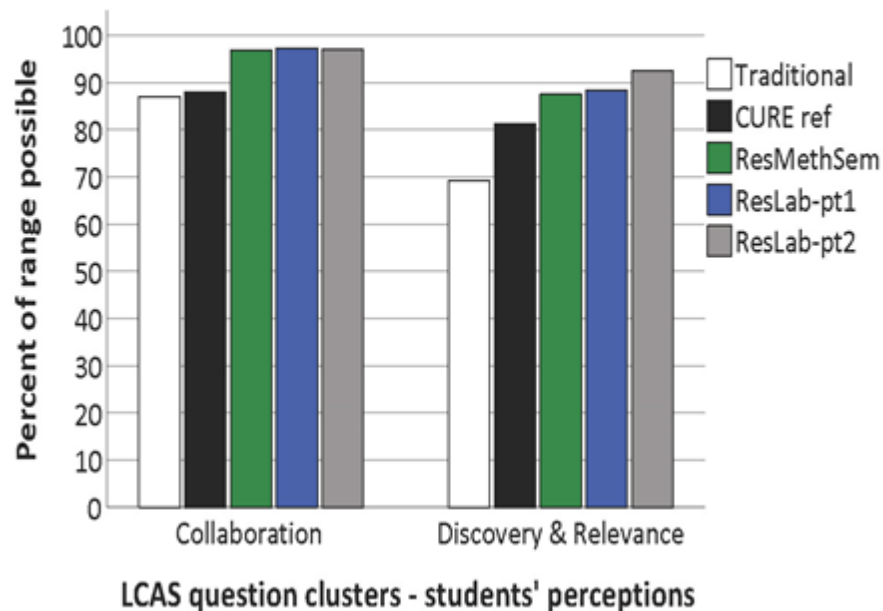
# Program Assessment

- ◆ End of Semester Survey
  - ◇ Laboratory Course Assessment Survey (LCAS)
  - ◇ Lopatto's CURE survey
  - ◇ General course evaluation
- ◆ Reflection Essays
- ◆ Student Tracking (after FRI experiences, graduation, etc.)

# LCAS Survey

- Measures students' perceptions of features that distinguish CUREs from traditional lab courses
  - Collaboration
  - Discovery & Relevance
  - Iteration

A) Mean comparison BU-FRI (cohort #4) of each CURE course in sequence to national data



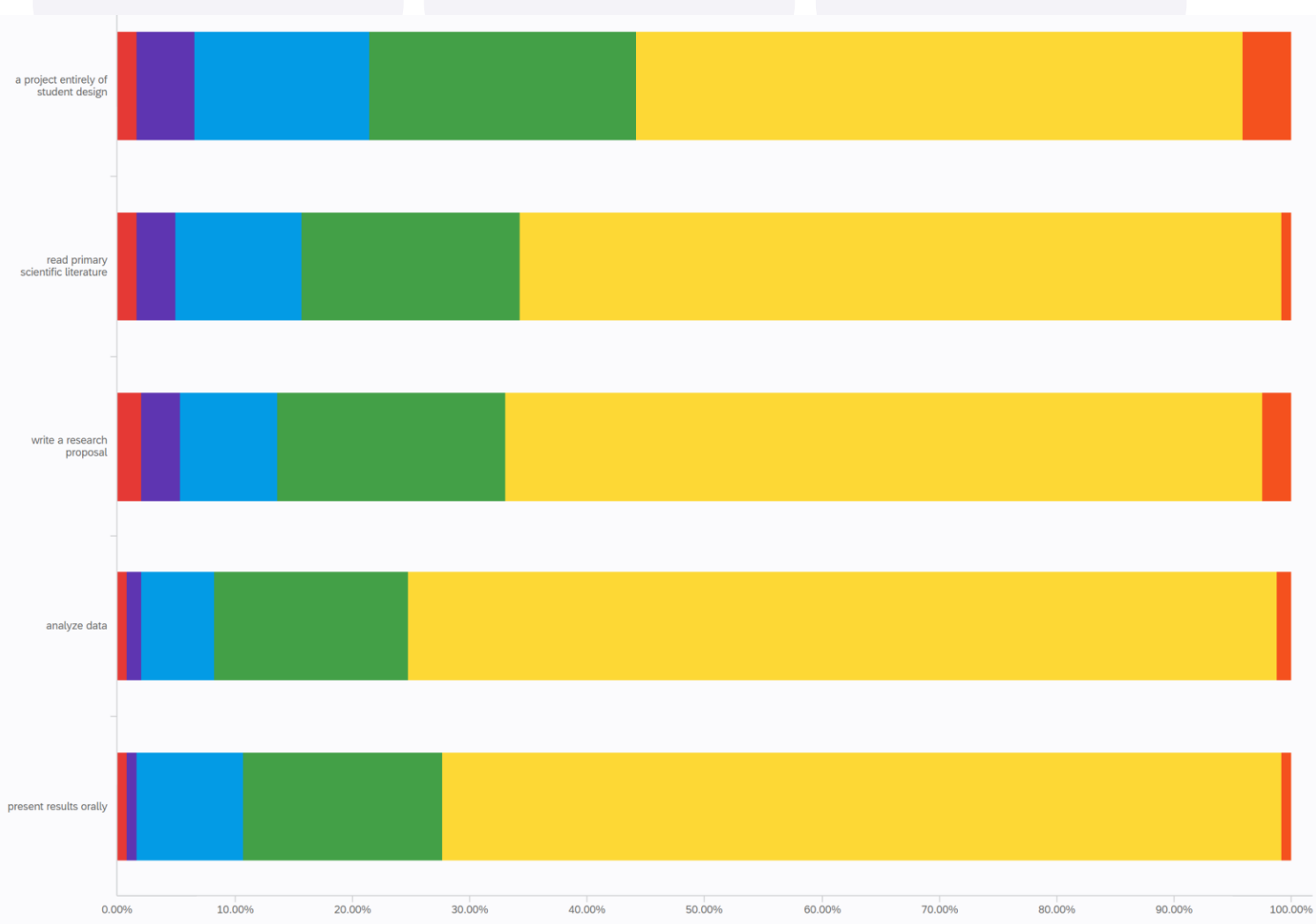


# CURE Survey

- Student perceptions of learning experience, nature of science, their own learning styles, and science-related skills they developed from participating in a CURE.

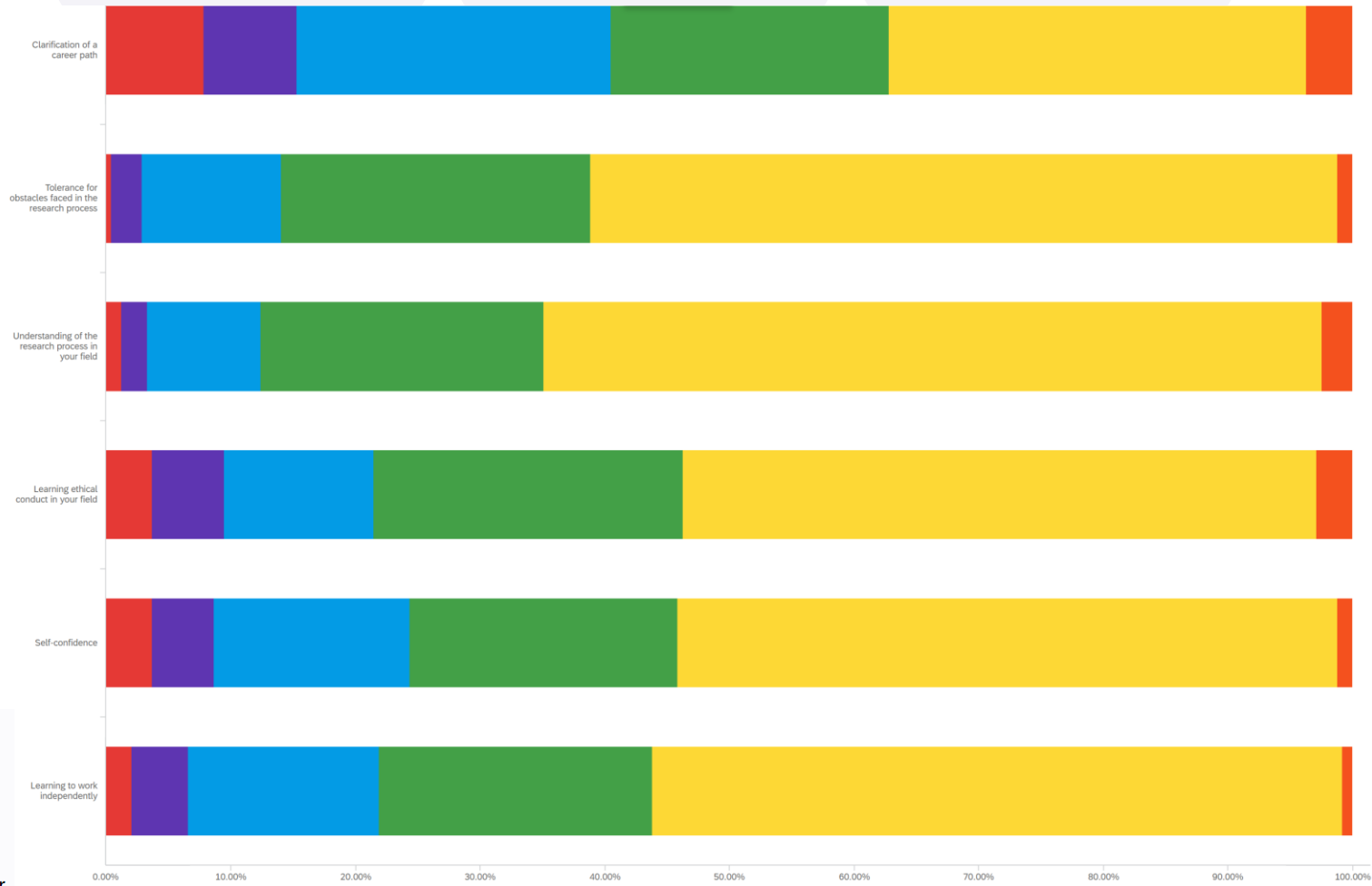
# CURE Survey – Course Elements

Fall 2021  
3<sup>rd</sup> Semester



# CURE Survey - Benefits

Fall 2021  
3<sup>rd</sup> Semester





# Reflection Essays - Analytic Skills, Impact Beyond Program

- “While other classes focused on providing material for exams, the FRI program focused on **building essential skills I know will be marketable in the future**. The greatest benefit of the FRI program has been the **growth of critical thinking skills** relating to a laboratory-research setting. The majority of days **experiments were led and designed by students**, with only little aid from the professor, which was **invigorating**.”





## Reflection Essays – Scientific Aspiration

- “I am very fortunate to have gone through FRI because of the skills it has instilled within me, and because of the **direction it has pointed me towards on the path to my career.** I value the interest it has given me in conducting research, the scientific method, and the pursuit of knowledge.”



# Reflection Essays – Ability to Navigate Uncertainty

- “I have learned the process of research and **resilience**. In science, not everything is going to work perfectly every time, and I now have a better handle on revising and editing techniques and protocols when an assay does not go exactly as planned. Even when something does not work and does not appear to have any value, there is always something to be gained from that trial.”

# FRI Student Outcomes

## College Students' Reports of Changes in Mental Health During the COVID-19 Pandemic

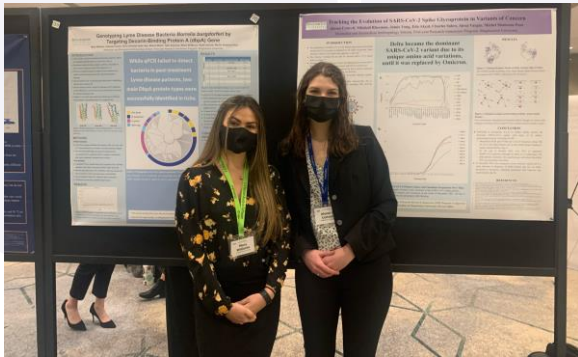
Devin Link



Dr. Jodi Dowthwaite, Committee Chair  
Dr. Jennifer Gillis, Committee Member  
Dr. Christina Balderrama-Turbin, Committee Member

### Public Health student

Mid-Atlantic Regional Meeting of American College of Sports Medicine



Molecular & Biomedical Anthropology students  
AABA National Meeting, Denver, Colorado



Article

## Applying Deep Learning to Automate UAV-Based Detection of Scatterable Landmines

Jasper Baur <sup>1,\*</sup>, Gabriel Steinberg <sup>2</sup>, Alex Nikulin <sup>1</sup>, Kenneth Chiu <sup>2</sup> and Timothy S. de Smet <sup>1</sup>

<sup>1</sup> Department of Geological Sciences and Environmental Studies, Binghamton University, 4400 Vestal Pkwy E, Binghamton, NY 13902, USA; anikulin@binghamton.edu (A.N.); tdsmet@binghamton.edu (T.S.d.S.)

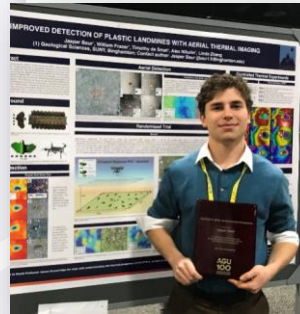
<sup>2</sup> Department of Computer Science, Binghamton University, 4400 Vestal Pkwy E, Binghamton, NY 13902, USA; gsteinb1@binghamton.edu (G.S.); kchiu@binghamton.edu (K.C.)

\* Correspondence: jbaur1@binghamton.edu

Received: 29 January 2020; Accepted: 1 March 2020; Published: 6 March 2020



**Abstract:** Recent advances in unmanned-aerial-vehicle (UAV)-based remote sensing utilizing lightweight multispectral and thermal infrared sensors allow for rapid wide-area landmine contamination detection and mapping surveys. We present results of a study focused on developing and testing an automated technique of remote landmine detection and identification of scatterable antipersonnel landmines in wide-area surveys. Our methodology is calibrated for the detection of scatterable plastic landmines which utilize a liquid explosive encapsulated in a polyethylene or plastic body in their design. We base our findings on analysis of multispectral and thermal datasets collected by an automated UAV-survey system featuring scattered PFM-1-type landmines as test objects and present results of an effort to automate landmine detection, relying on supervised learning algorithms using a Faster Regional-Convolutional Neural Network (Faster R-CNN). The RGB-visible light Faster R-CNN demo yielded a 99.3% testing accuracy for a partially withheld testing set and 71.5% testing accuracy for a completely withheld testing set. Across multiple test environments, using centimeter scale accurate georeferenced datasets paired with Faster R-CNN, allowed for accurate automated detection of test PFM-1 landmines. This method can be calibrated to other types of scatterable antipersonnel mines in future trials to aid humanitarian demining initiatives. With millions of remnant PFM-1 and similar scatterable plastic mines across post-conflict regions and considerable stockpiles of these landmines posing long-term humanitarian and economic threats to impacted communities, our methodology could considerably aid in efforts to demine impacted regions.



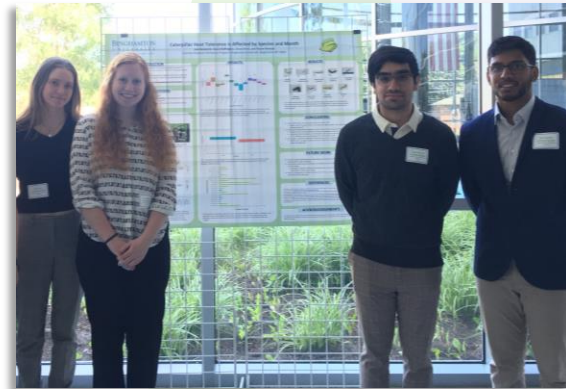
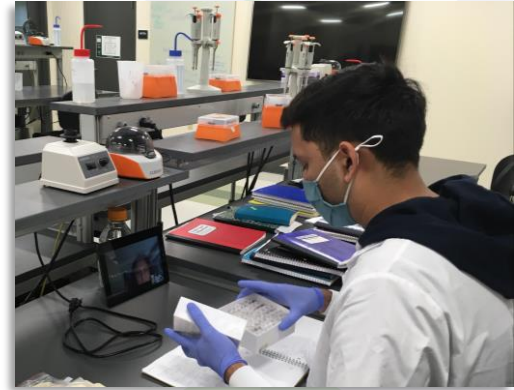
## AY 21-22 FRI Graduating Student Breakdown

- 50% participated in research beyond FRI (30% with with FRI faculty)
- 24% disseminated research externally
- 93% received STEM degree
- 85% 4-yr, 96% 6-yr graduation rates (> university goals)
- 46% secured employment, grad or professional school admission\*



# Summer Research Immersion (SRI)

- ◆ Summer session: 2, 4-credit CUREs
- ◆ 10 weeks
- ◆ 2-3 FRI research streams offered each summer
- ◆ Target: students struggling to obtain research experience (ex: transfer students)
- ◆ Collaboration with NSF REU programs for professional development programming



# Binghamton University STEM CURE goal

Every UG STEM major required to take a CURE, preferably early in college

Every UG STEM major has opportunity to take at least 2 more CUREs before graduating (3 CUREs total)



# Biology Department CUREs

◆ BIOL 115 – Intro Biology lab

◆ Advance Lab CUREs

◇ BIOL 340 – Genetics Lab  
(~200 students/yr)

◇ uses model system  
*Drosophila melanogaster*

◇ BIOL/BCHM 425 – Molecular  
Biology (~140 students/yr)

◇ BIOL 470/ENVI 430 – Plant  
Ecology



Received: 2 October 2018 | Revised: 18 October 2018 | Accepted: 20 October 2018  
DOI: 10.1002/ece3.4807

## ORIGINAL RESEARCH

WILEY [Ecology and Evolution](#)  
Open Access

### Inducible pesticide tolerance in *Daphnia pulex* influenced by resource availability

Vanessa P. Wuerthner | Jared Jaeger | Paige S. Garramone | Connor O. Loomis |  
Yelena Pecheny | Rachel Reynolds | Lindsey Deluna | Samantha Klein | Michael Lam |  
Jessica Hua | George A. Meindl

Biological Sciences Department, Binghamton University (SUNY), Binghamton, New York

**Correspondence**  
Vanessa Wuerthner, Biological Sciences Department, Binghamton University, Binghamton, NY.  
Email: vwuerth1@binghamton.edu

**Funding information**  
Binghamton University, Binghamton University's undergraduate research award

#### Abstract

Pesticides are a ubiquitous contaminant in aquatic ecosystems. Despite the relative sensitivity of aquatic species to pesticides, growing evidence suggests that populations can respond to pesticides by evolving higher baseline tolerance or inducing a higher tolerance via phenotypic plasticity. While both mechanisms can allow organisms to persist when faced with pesticides, resource allocation theory suggests that tolerance may be related to resource acquisition by the organism. Using *Daphnia pulex*, we investigated how algal resource availability influenced the baseline and inducible tolerance of *D. pulex* to a carbamate insecticide, carbaryl. Individuals reared in high resource environments had a higher baseline carbaryl tolerance compared to

# BIOL 115 – Intro Biology Lab

- ◆ Impact of human activities on:
  - ◇ Soil composition & microbial communities
  - ◇ Early plant development & growth
- ◆ **Started:** Fall 2018
- ◆ **Enrollment:** ~850/year
- ◆ **Staffing:** Lecturer/Coordinator + Grad TAs + UG TAs

<https://www.binghamton.edu/news/story/3614/planting-the-seeds-biology-lab-course-introduces-students-to-research>



21 April 2022

Translator Disclaimer

## Exclusion of Overabundant White-tailed Deer (*Odocoileus virginianus*) Results in Shifts in Soil Microbial Communities and Abiotic Soil Condition in a Northeastern Deciduous Forest

Brendan E. Enochs, Jonathan Chong, Miranda A. Kearney

Author Affiliations

The American Midland Naturalist, 187(2):173-194 (2022). <https://doi.org/10.1674/0003-0031-187.2.173>

ARTICLE

FIGURES & TABLES

REFERENCES

CITED BY

### Abstract

Past and current anthropogenic practices have resulted in dramatic alterations to ungulate population densities worldwide. When ungulate populations are overabundant, they can alter the dynamics, structure, and function of ecosystems. White-tailed deer (*Odocoileus virginianus*), specifically, can occur at densities

# 3 Phases of BIOL 115

## 1. Framework Phase

Develop foundation in research theme

Learn teamwork

Practice using equipment, developing hypotheses, analyzing data, and developing protocols

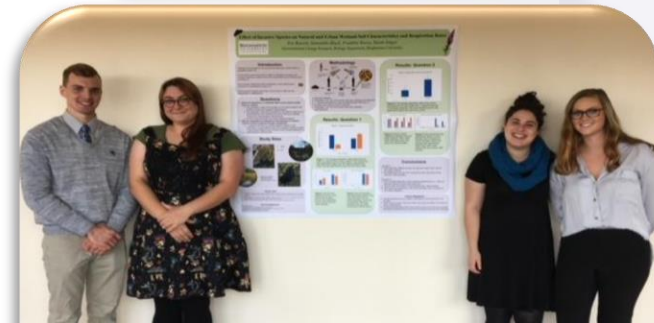
## 2. Research Phase

Teams develop novel research hypotheses and design and execute the necessary experiments and measurements to test these hypotheses.

## 3. Reporting Phase

Teams produce:

- Scientific poster
- Final scientific report





# Chemistry Department CUREs

- 4 general chemistry tracks – 1600+ students/yr
  - **CHEM 104/105/106** track = **CURE lab**
    - Pre-health & science major track (except chem/biochem)
    - Plans to convert other 3 tracks to CURE labs (engineering, nursing & chem/biochem)
- Advanced Lab CURE - Inorganic materials



# CHEM 106 – General Chemistry Lab

- ◆ Pre-health & science major track
- ◆ Chemistry of Environmental Water Quality
  - ◇ Field site: Campus nature preserve (20 acres wetlands area)
  - ◇ Vernier sensors: temperature, pH, conductivity, ion concentration, etc.
- ◆ **Started:** Fall 2020
- ◆ **Enrollment:** ~800 students/year
- ◆ **Staffing:** Lecturer/Coordinator + Grad TAs



# Additional Binghamton CUREs

- **ENVI/GEOL 342 & GEOL 465/565** – Environmental Hydrology & Measurements
- **ANTH 393 & 493** – Basic & Advanced Methods in Anthropology
  - Lyme and other tick-borne illnesses
- **HWS 332** – Nutrition
  - Diet, sleep, exercise, substance abuse & mental health



# Source Project

First-year Research Experience in Humanities  
and Social Sciences



# Source Project

- ◆ Directed by UG Research Center
- ◆ Enrollment: 150 students
- ◆ Started: Fall 2019
- ◆ Sequence of two, 4-credit courses
  - ◇ Fall – research methods & theories seminar
  - ◇ Spring – research project (team or independent)
- ◆ Courses taught by tenure-track faculty



# Source Project Research Streams 2022-23

- Human Rights
- History and Capitalism
- People, Politics & the Environment
- Pandemic!
- Social Context of Learning
- Disinformation and Naivité





**Dr. Sonja Kim**

Associate Professor  
Asian & Asian American Studies

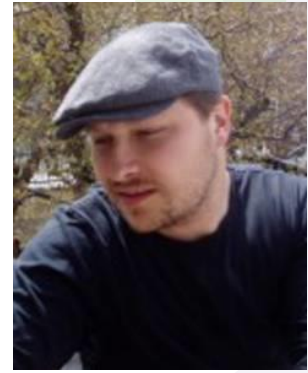
## Disinformation and Naiveté

- How does the lack of knowledge of other nations and cultures affect our lives?
- Russian projections of disinformation as a model for study of other cultures



**Dr. Sidney Dement**

Associate Professor  
German and Russian Studies



**Dr. Michael Kelly**

Visiting Assistant Professor  
Classics and Comparative Literature

## History and Capitalism

- How does interpreting Biblical, Greek, Roman, medieval texts help us interpret major ideologies, like capitalism, today?
- Participation in international groups of students

## Pandemic!

- How does understanding health management historically prepare us to address current health concerns?
- Case studies from 1800-1900s to present day Covid-19





# Considerations for CURE Implementation



Institutional Buy In  
Funding & Sustainability  
Instructional Staff  
Partnerships



# Institutional Buy In

<b>Faculty</b>	<b>Administrators</b>
<p><b>Typical motivations:</b></p> <ul style="list-style-type: none"><li>• Want better ways to engage students</li><li>• Want student researchers for more than 1-2 years it takes to train them</li><li>• Confident that reaching students early is better</li><li>• Interested/experienced in CURE</li><li>• Interested/experienced in education grants</li></ul>	<p><b>Typical motivations:</b></p> <ul style="list-style-type: none"><li>• Issue to resolve<ul style="list-style-type: none"><li>○ Students not engaged in intro courses</li><li>○ Diversity students don't see career</li><li>○ Low DFW rates in intro courses discourage talented students</li><li>○ "Undecided" need focus or gateway</li></ul></li><li>• Other issues</li><li>• External funding opportunities</li></ul>
<p><b>Typical concerns:</b></p> <ul style="list-style-type: none"><li>• Can't add to faculty workload</li><li>• Departments don't have budget for this</li><li>• No lab space to spare</li><li>• Can CURE students really do publishable research?</li></ul>	<p><b>Typical concerns:</b></p> <ul style="list-style-type: none"><li>• Costs?</li><li>• What are quantifiable benefits, how soon will these materialize, and to what degree?</li><li>• Can some current resources support this?</li></ul>



# Guidance: Identify high priority outcomes

Each institution has a unique student population and associated set of both strengths and challenges.

## Initial Questions:

1. What are your institutional **priorities**?
2. What are your **impediments** to change?
3. Do you have a **quantitative** understanding of recruitment, persistence, matriculation and graduation patterns?
4. What are your **subpopulations** of success and challenge?
5. At what **stage of matriculation** are you seeking transformation?
6. Where are you **behind, at-pace and leading** and can you leverage?





# Binghamton Strategic Priority #2 - Learning Community:

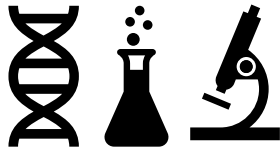
- ◆ Provide a transformative learning community that prepares students for advanced education, careers and purposeful living.
  - ◇ **Goal: Binghamton University student experience is characterized by robust and equitable access to high impact practices (HIP's) identified as institutional priorities.**
    - ◇ HIP Target: 100% 2026

# Funding & Sustainability

- Expenses for CUREs & CURE sequences



Instructor (+ teaching assistants/peer mentors)



Supplies & Equipment



Administrative Staff



Dissemination & Professional Development

# Research Educators vs Tenure-Track Faculty

## ● FRI Research Educators

- Finding the right individuals can be challenging (need teaching & research strength)
- No tenure/promotion pathway
- Dedicated to the FRI program
- Community of Practice

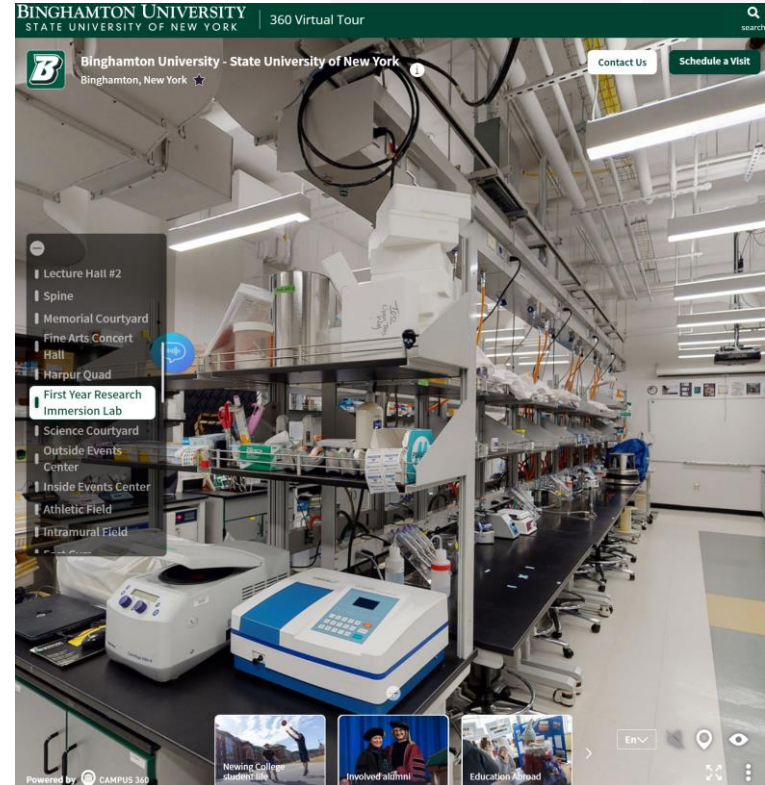
## ● Source Project Faculty from Arts & Science College

- Pool of faculty available but approval needed from departments/dean
- Have many non-source project responsibilities

**Challenge:** workload of CURE course is usually greater than traditional lecture course

# Campus partnerships are crucial!

- ◆ Admissions & enrollment management
  - ◇ FRI is a major reason students come to Binghamton
  - ◇ Student recruitment process
- ◆ Academic colleges & departments
- ◆ Career center
- ◆ Alumni office





# THANK YOU!

Any questions?

- ◆ [www.binghamton.edu/fri](http://www.binghamton.edu/fri)
- ◆ [mfegley@binghamton.edu](mailto:mfegley@binghamton.edu)