Engaging Pre-Service Teachers in STEM Research

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This presentation is being recorded. The recording and slides will be available in the coming week at

https://aaas-arise.org
About AAAS

The AAAS seeks to "advance science, engineering, and innovation throughout the world for the benefit of all people."

https://aaas.org

About ARISE

- AAAS ARISE network collects and shares information about topics and strategies for research and evidence-based approaches to:
  - prepare STEM teachers for the future
  - assess efficacy in STEM teaching
  - understand effective ways to recruit, train, and retain a quality STEM teacher workforce

https://aaas-arise.org  AAAS ARISE Network  @NoyceProgram
Lived experiences in teaching and research: Strategies for preparing scientists that become teachers

As part of the AAAS ARISE workshop “Engaging Pre-Service Teachers in STEM Research”

Christine Cutucache, Ph.D.
The Need for the NoyceSCIENCE program

• Teaching needs in Nebraska
• H3 jobs
• Workforce deficits in STEM
• Teacher-preparation pathways
Programmatic Overview

• **Generated dual-pathways** (Biology, Chemistry, Geol/Geography, and Physics)

• **Recruited** from students who changed majors part-way through a pre-med degree and from first year science courses (doubled graduates)

• Prioritize research, teaching, and community **engagement activities**
Participants get PD specific to employment

- **Mentoring** from science and education faculty

- **Networking opportunities** via Omaha STEM Ecosystem, local districts (MOEC), research dissemination at conferences, and via AAAS-sponsored events

- **Teaching experience** via a community outreach program called NE STEM 4U

- **Teaching & research experience** serving as learning assistants in course-based undergraduate research experiences (CUREs)
Themes

- **Research**: preparing future teachers to be *scientists* first, then teachers
  - DBER & CURE-based
  - Primary advisor, but more often we have research *teams*
    - Culturing phages from Nebraska water sources
    - Investigating learning outcomes from youth in an afterschool science program
    - Meta-analyses of the effect of mentoring on mentors

*Students report the significance of research experiences for content learning and overall professional development*
Professional Development

• Targeting PD focused on cultivating 21st century skills:
  • Problem solving and critical thinking
  • Professionalism
  • Dependability
  • Communication, communication, communication

Nelson, Rauter, Cutucache CBE LSE 2018
https://doi.org/10.1187/cbe.18-03-0038
Chickering’s Dimensions


Progression through the dimensions

Critical components for pre-service research experiences

• Engaged mentors with timely, content-specific research projects

• An opportunity for community engagement (as a value-added, or embedded into the project itself, such as phages in the environment)

• Near-peer network

• Ways for students to disseminate knowledge
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• Dr. JJ Conrad
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• UNO College of Arts and Sciences and College of Education, Health, and Human Sciences
Share your thoughts!

Contact me!

@STEMTRAILCenter
Engaging Pre-Service Teachers in STEM Research
NSF ARISE webinar Oct 2021
Outline

● Why engage pre-service teachers in STEM research?
● Noyce Berkeley 3-D Project
  ○ RET & IUSE synergies
● CalTeach Research Experiences
● Evidence for undergraduate learning
● Translating research experiences to the classroom
Why engage **undergraduates** in research?

- Improve understanding of scientific content
- Develop knowledge and skills in scientific practices
- Build an understanding of the nature of science
- Improve confidence and science identity
- Increase STEM retention and interest in STEM careers
Why engage **future teachers** in research?

In addition to benefits for all undergraduate researchers, pre-service teachers also:

● learn to promote inquiry for their future K-12 students, especially with a deeper understanding of scientific & math practices

● develop a research stance for their own teaching practices
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CalTeach: Who are we?

- Undergraduate STEM teacher education program

- CalTeach students simultaneously earn STEM degree and secondary math or science teaching credential

- Courses require CalTeach students to engage in research experiences and/or K-12 field work
**CalTeach: By the Numbers**

- **500** student course enrollments annually
- **400** field placements in local K-12 classrooms
- **50-75** complete CalTeach minor
- **30+** summer research and museum internships
- **25** receive CA teaching credential...and growing
- **10-14** Noyce Scholars
“Digging Deeper with Data” Project: Noyce Berkeley 3-D Broader Impacts

● CalTeach recruits diverse undergraduate population, contributing to increased diversity for CA teachers

● Anti-racist STEM pedagogy is integrated across course curriculum, including use of data science approaches to explore & analyze data sets with a social justice lens

● Prepare urban and rural K-12 students for college majors and careers involving STEM data literacy
Noyce Berkeley 3-D
Specific Aims

Recruit STEM undergrads into teaching
● 65 Noyce Scholars across 3 partner programs
● 90 internships - museums, classrooms, research

STEM Data Literacy integration
● CalTeach course curriculum & STEM research groups
● workshops facilitate by Noyce alumni
● PD for faculty in data science

Research and Program Evaluation
● STEM data literacy teaching among our graduates
Synergies between CalTeach NSF projects: Noyce, RET and IUSE

- Noyce scholars required to engage in research to complete CalTeach minor and teaching credential

- Coursework includes STEM data literacy & research
  - EDUC C122 - fall and spring CURE
  - EDSTEM 189 - aligned with full-time summer research funded primarily by RET award (BERET+D)

- NSF IUSE extends our research on Noyce & BERET+D
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How do CalTeach Undergraduates support Berkeley STEM Research Efforts?

- Astronomy
- Biomechanical Engineering
- Chemical Engineering
- Civil & Environmental Engineering
- Computing, Data Science & Society
- Electrical Engineering & Computer Science
- Graduate School of Education
- Joint BioEnergy Institute
- Mechanical Engineering
- Molecular & Cell Biology
- Natural Resources
- Nuclear Engineering
- Physics
- Vertebrate Zoology
Examples of Research Internships that Support K-12 Students

- **Berkeley Computing, Data Science, & Society (CDSS)**
  - learn data analysis techniques with high school students
  - examine data through a social justice lens

- **Joint BioEnergy Institute (JBEI)**
  - learn microbiology concepts and research techniques
  - plan and carry out investigations related to alternative fuels
  - design learning modules for secondary students

- **Web-Based Inquiry Science Environment (WISE)**
  - evaluate web-based resources to help students examine the impact of environmental racism on health
  - analyze student data to identify factors related to student identity and conceptual understanding
How does CalTeach support Undergraduate Researchers?

● Fall/Spring ‘CURE’ Research Method course, or

● Summer Research Institute (SRI)
  ○ 8-week paid, fully immersive internship
  ○ Accompanying 3-unit upper division Course
    ■ Research methods for math/science/data science
    ■ Develop identity as a math, science, data science researcher
    ■ Translate research skills into inquiry-driven, standards-based lesson design
  ○ Additional Guidance
    ■ Scientific writing workshops (opportunities for publication)
    ■ Research showcase events and career panels
    ■ Mentoring from collaborating In-Service Teachers
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Evaluation & Research

● What do undergraduates learn from research experiences?

● How do CalTeach students and graduates translate what they have learned in research placements & coursework to math and science teaching?
**BERET+D Evaluation & Research**

- What do undergraduates learn from research experiences?

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<th>Pre/Post Survey Analysis</th>
<th>Final Portfolio Reflections</th>
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<td>Opportunities to practice planning and carrying out investigations are essential.</td>
<td>“I believe that my personal view of research has changed because before I did not think I had a place in research… Now, I see the importance of continuing scientific research because of how it will benefit me as an educator.” - JM.</td>
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<td>Data analysis is an essential skill for all children, particularly those in highly impacted communities.</td>
<td>“Teaching data science allows teachers to integrate research into the classrooms… I now see myself as a scientist and believe that I can teach my students to impact the world through data science.” - MF.</td>
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<td>Data science instruction for all students is more accessible now given widely available resources.</td>
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"I believe that my personal view of research has changed because before I did not think I had a place in research… Now, I see the importance of continuing scientific research because of how it will benefit me as an educator.” - JM.

“Teaching data science allows teachers to integrate research into the classrooms… I now see myself as a scientist and believe that I can teach my students to impact the world through data science.” - MF.
How do CalTeach students translate what they have learned by doing research to their future math and science teaching?

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<td>A majority of participants describe a clearer connection between conceptual understanding in math and science and having opportunities to engage with the NGSS Science and Engineering Practices, and Common Core Math Practices.</td>
<td>“What resonated for me is, I think it will be especially helpful for my students to practice asking questions and defining problems since this is at the very heart of science and thinking about ways to understand the things we don’t know.” - KH.</td>
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<td>“I saw the practices in everything I did over the summer. But, more important that any one SEP or math practice is giving my students the language to describe what they are doing. This is so they can articulate exactly what practice they are using... This will help them see the process behind what they do.” - PT.</td>
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● Translating research experiences to the classroom
Translating research into the classroom

- Extend RET and Noyce program evaluation in an IUSE collaboration with Department of Chemistry
  - Berkeley Undergraduate Research Evaluation Tools (BURET) research team: Anne Baranger, Marcia Linn, Max Helix and Laleh Coté
Translating research into the classroom

● NSF IUSE - BURET Research questions:
  ○ What do undergraduate researchers learn about scientific content and research practices? *(in press: Chem Ed Research & Practices)*
  ○ What is the impact of a graduate student mentoring workshop?
  ○ In what ways do Cal Teach undergraduates translate their research experience into K-12 classroom practices?
Translating research into the classroom:
Case 1

“As part of these research experiences [characterizing thermal and electrical conductivity], I had to develop models to help explain these phenomena. I try to translate that models-based thinking into my classroom by my students collecting data and graphing it, or drawing pictures, or constructing verbal explanations in discussions with them.” - Mr. C
Translating research into the classroom:

Case 2

“[I have] my students create notebooks with their thoughts and ideas as they develop with the material. I also try to have my students think outside the box to try and solve problems and lead the learning in the classroom.” - Ms. L
Translating research into the classroom:  
Case 3

“My comfort with reading primary literature allowed me to synthesize a paper measuring water turbidity, and create a simple apparatus to my work with Tanzanian students so that they could evaluate their local water supply and improve health in their community. I later brought this lesson into my high school class in Oakland.” - Ms. A
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Questions?