Broadening Participation in Research through Collaborative STEM Teacher Professional Development Program Models

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BTI Discovery & Innovation in the Life Sciences
BOYCE THOMPSON INSTITUTE

Overview

Broader Impacts (BI) are a critical component of the National Science Foundation's mission and are integral to competitive research programs across the country. BI criteria aim to ensure that scientific knowledge and the scientific enterprise remain relevant and provide direct benefit to society. Special attention is given to increasing access and opportunity in STEM fields to communities that are persistently underrepresented, including most minority groups, women, first generation college students, as well as under-resourced rural and urban communities. BI criteria aims to promote greater public engagement with science, increase scientific literacy, improve STEM education at all levels, and prepare a new and diverse generation of scientists.

BTI's Education and Outreach (EO) programs closely align with BI criteria, while focusing on academic and career development opportunities of students and teachers in plant sciences, bioinformatics and related STEM fields. Over 20 plant genome and bioinformatics laboratories at BTI, Cornell University and the USDA Liberty Hyde Baily Center participate in integrated Broader Impacts programming through BTI's EO department. On average 10-12 NSF and USDA grants are co-designed and managed through the department and focus on young adult to adult participants.

One major aim of our work has been to develop a program model that increases teacher confidence in teaching challenging STEM content and leading extended inquiry practices in their classrooms based on current STEM research questions that have potential to impact society. When participants implement, adopt, or take ownership of their learning and share it with others I refer to as Meaningful Program Design.

Methods for Meaningful Program Design

Ensure that all participants benefit from collaboration in multiple ways, and that benefits are measurable (Figure 1)

Align Program Elements and Goals with Adult Learning Theory and Best Practices (Figure 2)

Program Elements

- Summer Learning Institutes
- Teacher Workshops
- Curriculum Development
- Classroom Experiment Kits
- Citizen Science Projects
- Teacher Leadership
- Alumni Collaboration

STEM Teachers at BTI design curriculum and experiments for the classroom based on current plant research questions, faculty seminars and the Next Generation Science Standards.

Teacher Institutes Goals

- Increase teacher content knowledge in STEM, emphasizing science and society issues including genetics, heredity, and genomics, biotechnology, agriculture, bioenergy, systems thinking, sustainability and climate change
- Increase teacher confidence in teaching this content using scientific inquiry
- Support teachers that aim to lead change by engaging students in authentic STEM inquiry through the develop lesson plans, web-based resources, methods, and materials with teachers and scientists and facilitate feedback and data sharing between schools and BTI scientists.
- Create a professional learning community through careful selection of annual teacher cohorts and includes multiple opportunities to interact and engage over time, including, curriculum development, lesson implementation, experiments in the classroom, national conferences, and publication

Program Models

Figure 1: A Program Design Model for Meaningful Engagement
Identify the unique and measurable benefits that all participants will experience through collaboration and interaction. (Adapted Lally et, al.,The Plant Cell 2007)

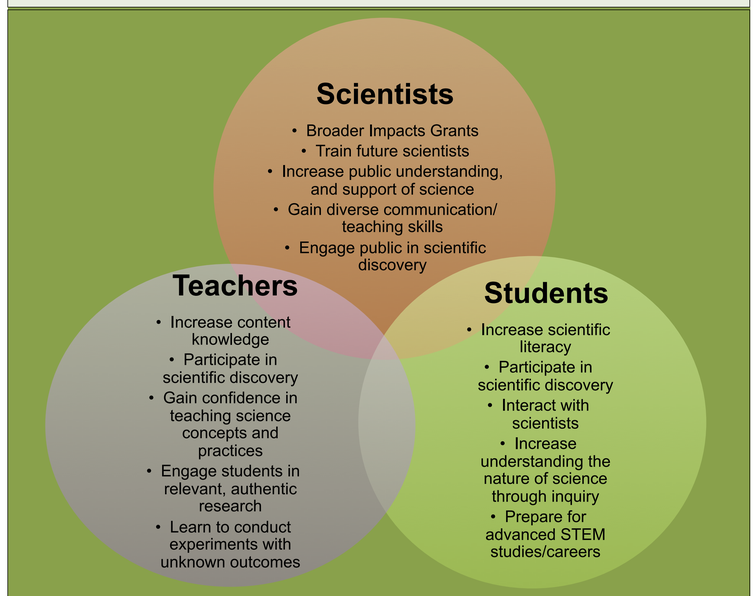
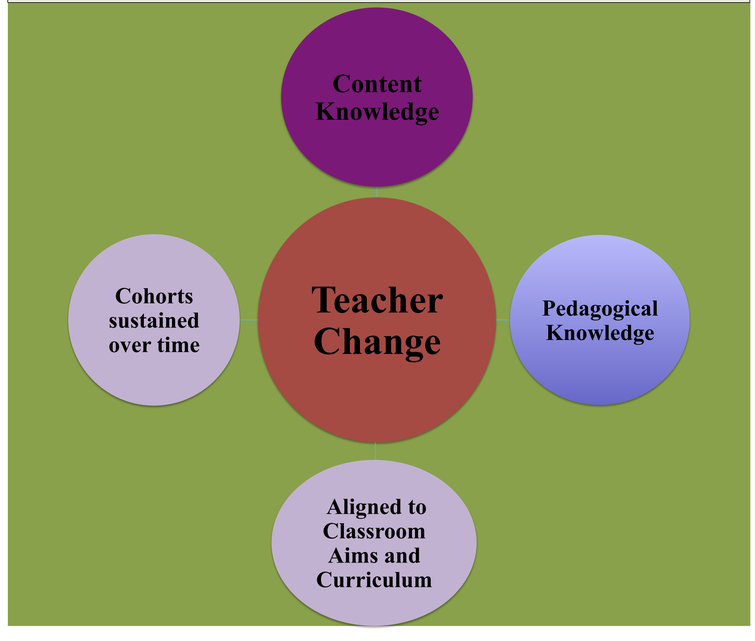


Figure 2: A Cohort-Based Long-term Professional Development Model to Support Teacher Change in the STEM Classroom



Results

1. Teachers report increases in their confidence to teach STEM concepts as a result of teacher institute seminars, lab experiments, and collaborative curriculum development activities (See Figure 3).

2. Over 4,000 individuals participated in BTI's BI Programs in 2015, with STEM teachers extending the impact to 3,442 secondary students across the country. (See Figure 4). Partner teachers are recruited from urban and rural communities. In 2015 69% of these projects were integrated in "high needs" schools.

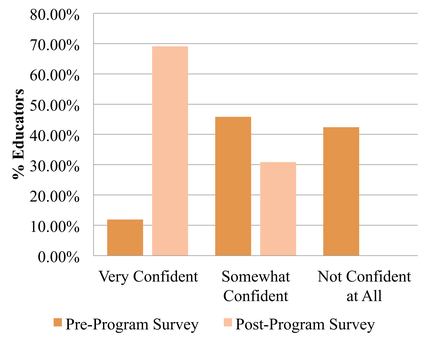


Figure 3: BEP Teacher Institute Pre/Post-Survey Results, Confidence in teaching Biomass, Bioenergy and Bioproducts STEM topics increased for the 56 participating teachers.

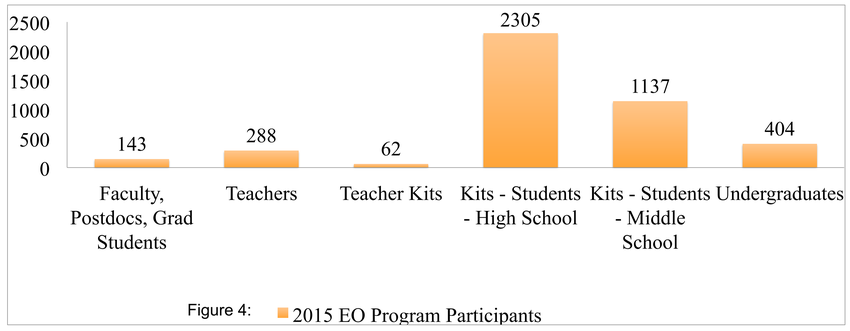


Figure 4:

Partner Classroom in Buffalo, NY

"…hearing about the research from the lead scientists gave me better insight on how to make the work real to my students and allow them to be a part of scientific work beyond their school"
-STEM teacher

Teacher Leadership, Alumni Posters

Future Directions

Demonstrate Impacts Unique to Each Participant Type
Form focus groups, surveys and assessment tools to determine how this Broader Impacts Model Program supports each participant type in the ways outlined in Model 1, Figure 2. In particular, what benefits do students experience as a result of participating in extended inquiry-based projects in the STEM classroom? Literacy gains? Scientific identify, persistence?
Community Building
Continue to strengthen and interact with the teacher network through social media, to exchange STEM teaching ideas, methods, classroom and BTI lab results.. See #BTIinClass

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