Integrating High School Students & K-12 Educators into Undergraduate Research

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Abstract

For the past five years, researchers in the sciences at Bradley University have integrated high school students and K-12 educators into their labs. We have developed a scientific community of layered mentors where faculty oversee projects, and graduate and undergraduate students mentor K-12 educators and high school students. This community participates together in research-based activities, educational opportunities, and social events. Our goals include providing K-12 educators with experiences and skills that will enable them to engage their classroom, giving high school students a greater appreciation for science as a profession, and building undergraduate researchers' communication skills. All participants appear to have gained from the experience. K-12 educators and high school students show increases in their understanding of science and confidence in their scientific abilities. Program administrators, faculty mentors, and student mentors feel a part of something larger than their own research programs by contributing to the next generation of scientists.

Program Design

- Participants collaborate in research projects designed by faculty mentors, graduate students, and undergraduates.
- Projects are designed to allow responsibility for data generation to be shared by all team members, including those with modest scientific backgrounds.
- Research-based activities include:
  - Workshops
  - Seminars
  - Brainstorming sessions
  - Social events
  - Fieldwork
  - Lab work

Interrelated Research

- *Umbrella topic*: Chosen by the faculty leading the research, it is deliberately chosen to be broad in scope and with nearly unlimited avenues for research, in order to demonstrate continuity across years and researchers. (In our example, the focus is on invasive plant species biology, and the general question of how invasive species might be controlled.)
  - *Focal topics:* Faculty can then carve out several smaller questions or challenge undergraduate students to develop smaller questions based on the overall theme.
    - *Subtopics:* High school students and K-12 educator colleagues are then challenged to derive smaller projects related to the specific question being investigated by one or more of the undergraduate students. Undergraduate student mentors and faculty mentors help the high school student and K-12 educators develop their projects, design experiments, and ensure that they have the appropriate training to collect the data identified.

Umbrella Project Concept

A Mechanism Used with Great Success to Integrate Researchers of Varied Skill and Background into Real Scientific Research Projects

1 - Faculty mentors provide one or more umbrella questions that focus research efforts for the whole group.

2 - Senior research students (graduate and undergraduate students), in collaboration with faculty mentors, develop integrated research projects that fall under the general umbrella.

3 - Undergraduate students are encouraged to formulate specific testable hypotheses connected to one of the integrated research projects. High school student and K-12 educator interns are provided short, focused projects or tasks aligned with one of the integrated projects.

Green color arrows represent flow of information (hypotheses to be tested, background literature, methods, etc.) from faculty mentors and senior research students to undergraduate participants and high school students and K-12 educator interns.

Orange color arrows represent flow of information (data, methodological refinements, new questions to be included in integrated projects, etc.) from undergraduate participants and high school students and K-12 educator interns to faculty mentors and senior research students.

Blue color arrows represent the coordination of the multiple integrated research projects.

Benefits

- High school students and K-12 educators experience the scientific and real world contexts for project goals and experimental designs.
- All interns recognize the importance of their project to the overall research goals of the group.
- There is a clear peer-group from whom to draw on for expertise, extra hands, and trouble-shooting.
- The larger group serves as a sounding board for questions that arise in any of the subprojects

Positive Outcomes

All Participants:

Gained increased understanding of the nature of science, increased science self-efficacy, and increased awareness of science careers.

Undergraduate participants:

Developed skills of responsibility and problem solving that will increase their success as college students and as they emerge as young scientists.

K-12 educators:

Showed marked improvement in developing testable hypotheses, in understanding basic elements of experimental design, in utilizing statistical methods to analyze data, in using data to evaluate hypotheses, in presenting data, and in relating experimental results to real-world scenarios and the start of a more sophisticated concept of the nature of inquiry-based science education.

High school students:

Increased their understanding of the nature of science and their confidence and ability to do science. Developed a sense of science as a process that they can contribute to, rather than an abstract body of knowledge generated by others.

Acknowledgements

Funding Sources
- National Science Foundation
- Annie E. Casey Foundation
- US Department of Labor/City of Peoria Workforce Development Dept
- Illinois Department of Economic Opportunity and Commerce/ Peoria Area Chamber of Commerce
- Illinois Math and Science Partnership program
- Bradley University, Center for STEM Education