The Power of Community in Implementing Classroom Undergraduate Research Experiences (CUREs)

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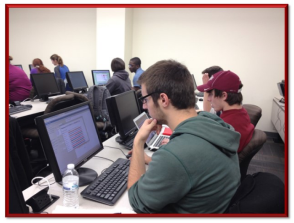
Abstract

Delivering undergraduate courses in genomics at Primarily Undergraduate Institutions (PUI) presents unique challenges. Course activities often become obsolete from year to year as online tools change rapidly. To address this issue, we have formalized a collaboration to develop Classroom Undergraduate Research Experiences (CUREs) in Genomics. The Genomics Education Partnership (GEP) was established as a community of faculty with a goal to provide professional development, software tools, and an overarching project framework that allow PUI faculty to provide publishable research projects in undergraduate courses. An overview of the community, classroom activities, and their pedagogical and research outcomes will be presented.



Introduction

GOAL: To provide undergraduates the opportunity to work on novel research experiments through a community-based genomics project as part of a course.

The Genomics Education Partnership (GEP) is a nationwide network of 250+ faculty members working to ensure all undergraduates, regardless of their background and available resources, can participate in genomics research by completing a Classroom Undergraduate Research Experiences (CUREs).

Projects are accessible through the internet and do not require campus research infrastructure to complete the project, so the GEP is a very cost-effective way for faculty and students to work together on a genomics-based research project. By working on this computer-based CURE, students get experience completing a novel research project, and learn how to use web-based genome browsers, bioinformatics tools, and databases to investigate genomes based on data that is available through the online project.

The project consists of gene annotation, which is the process of indicating the location, structure, and identity of genes in a genome.

Students must **evaluate** the available evidence, **create** the best gene model, and **defend** their conclusions.

Methods

Classroom Implementation / Student Projects

- Students engage in novel research within a course. They are provided gene annotation projects by the partnership.
- Students must evaluate the available scientific evidence, create the best gene model, and defend their conclusions.
- Students gain skills in scientific research, critical thinking, comprehension of genomic information, and have the opportunity to co-author publications.

Faculty Benefits

- Faculty are part of a community that provides curriculum, research projects for integration in courses, and technical support at no cost.
- Faculty have opportunities for professional development, including designing new curriculum, presenting at conferences, and publishing research results.
- Ability to provide undergraduate research opportunities in rapidly evolving fields such as genomics.

Scholarship of Teaching and Learning

- The GEP engages in the scholarship of teaching and learning by assessing both faculty and students who are involved
- Faculty surveys on implementation are also conducted
- Students pre- and post- course surveys and quizzes are completed based on previously published surveys related to personal agency, conceptions about science, and student interests, as well as persistence and determination.

Results

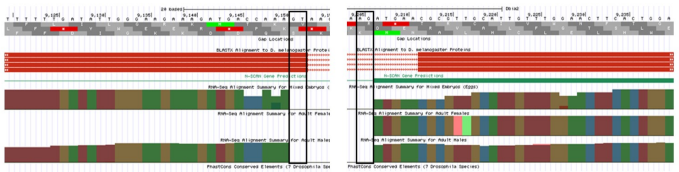


Figure 1. An example of a genomic region of *Drosophila* as visualized in a genome browser and various tools that are used by students in their annotation projects

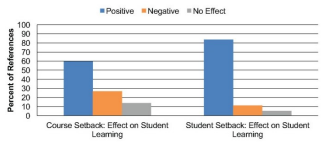


FIGURE 2 Faculty observe that setbacks in the research process promote student learning. Results from *NVivo* analysis of comments from the Formative Failure faculty survey on the effects on student learning from course setbacks (survey question 9.D: problems affecting all students in the class, *N*=161) and student setbacks (survey question 10.D: problems encountered by individual students, *N*=134). The percent of faculty responses that were positive (blue), negative (orange), or neutral (no effect; grey) are shown.

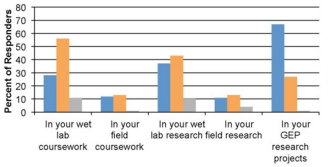


FIGURE 3 Faculty are more likely to let their students risk failure in GEP research projects than in wet bench or field work lab courses and research projects. Faculty were asked how likely they were to let students fail in performance of wet bench lab work (coursework and research), field work (coursework or research), and GEP research activities. The degree of willingness to risk failure was evaluated as 1 (very likely) to 3 (not at all). Note that many GEP faculty members do not do field work, so the number of responses in that category is lower. (Percentages do not sum to 100%, as "not applicable" responses are not shown.)

Conclusions/Significance

- Research projects are completed online which provides opportunities that are not costly and are accessible all the time without having students go to a physical laboratory on campus to work on their research projects.
- Students learn how to work through mistakes, and faculty are more likely to allow students risk failure in a supportive manner.
- Students that approach the CURE with positive attitude are more likely to have learning gains.
- Collaborations of this type may help faculty in other fields to provide learning opportunities for students that they could not do on their own in their courses.

Lock Haven University student quotes on an anonymous survey:

- As much as I struggled with the annotation project, I see it as useful to my education. In lab classes, one is kind of lied to with "cookbook" experiments. I enjoyed having the ability to "fail". The annotation project gave me something to be proud of.
- I learn better through experience. I hate doing pointless "in-the-box" labs. This was worth my time, taught me a lot and has a real, important outcome.
- It definitely helped me to learn more patience. But more importantly it put you in a situation where you don't know the outcome of your experiment which is something you rarely get as an undergrad.
- It teaches about the actual research process, especially the challenges of no one else knowing the answer.
- It taught me to work independently and forced me to learn what I was doing instead of memorizing.
- I had to use time management because this project wasn't something that could be done in a couple hours the night before it was due.
- It gave me hands on experience in the techniques described in lecture which I think is very important.
- The annotation project was, by far, the most useful project I have done in my collegiate career. Unlike most other projects, the answers were unknown, and that allowed for the feel of real scientific research.

Future Directions

The GEP is actively recruiting new members, especially faculty at Minority-Serving Institutions and Community Colleges. The GEP hosts free in-person and virtual new member trainings throughout the year.

Learn more about the GEP at https://thegep.org or scan the QR barcode for more information:

Reference

Lopatto, David, et al. "Student Attitudes Contribute to the Effectiveness of a Genomics CURE." *Journal of Microbiology & Biology Education* (2022): e00208-21.

Lopatto D, Rosenwald AG, DiAngelo JR, et al. Facilitating Growth through Frustration: Using Genomics Research in a Course-Based Undergraduate Research Experience. *J Microbiol Biol Educ.* 2020;21(1):21.1.6. Published 2020 Feb 28. doi:10.1128/jmbe.v21i1.2005

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