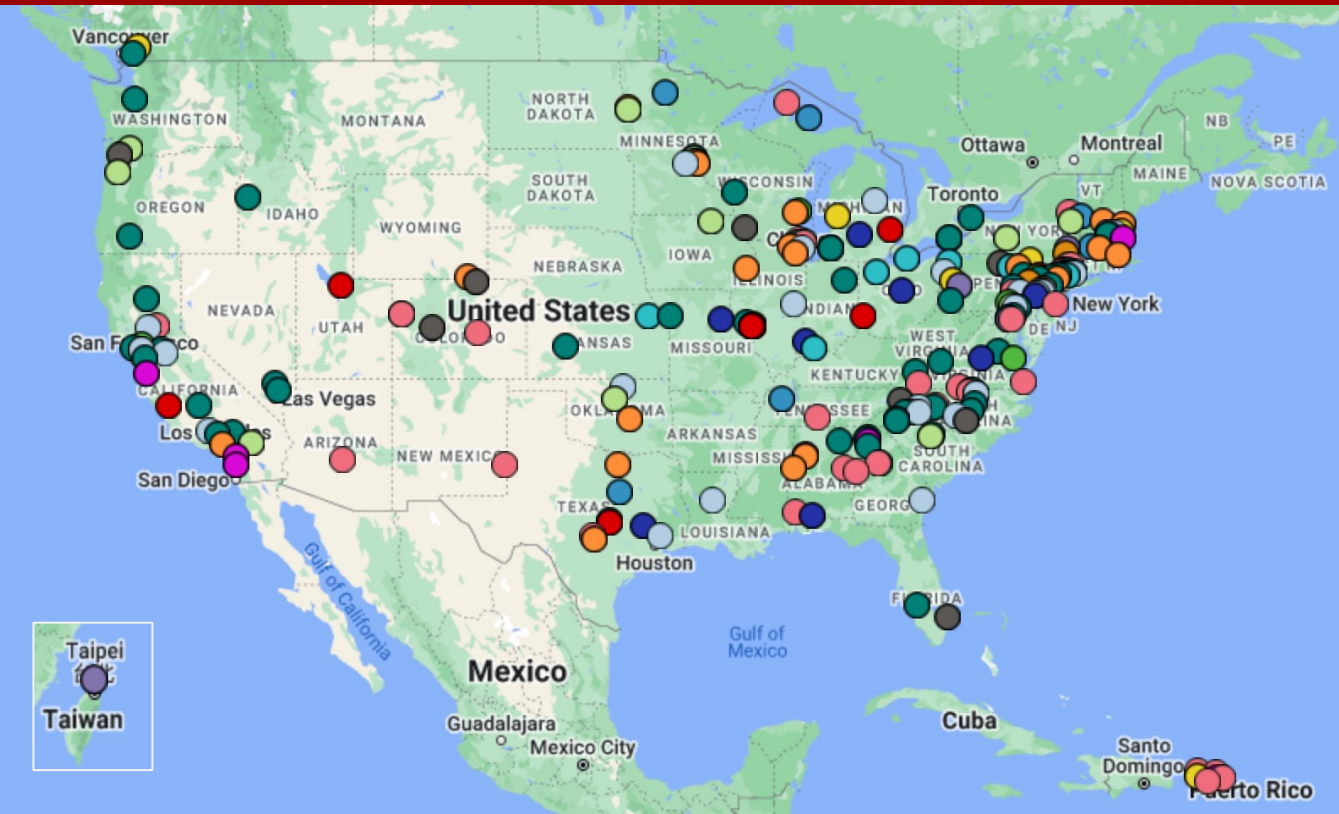


# The Genomics Education Partnership: Bringing Genomics Research into the Undergraduate Curriculum

Chan Hays<sup>1</sup>, Alexa Sawa<sup>2</sup>, Paula Croonquist<sup>3</sup>, Adam Haberman<sup>4</sup>, Wilson Leung<sup>5</sup>, David Lopatto<sup>6</sup>, Chinmay P. Rele<sup>7</sup>, Scott Tanner<sup>8</sup>, Sarah C R Elgin<sup>5</sup>, Laura K. Reed<sup>7</sup>, and The Genomics Education Partnership

(1) Western Colorado University, Gunnison, CO (2) College of the Desert, Palm Desert, CA (3) Anoka-Ramsey Community College, Coon Rapids, MN (4) San Diego University, San Diego, CA (5) Washington University in St. Louis, St. Louis, MO (6) Grinnell College, Grinnell, IA (7) The University of Alabama, Tuscaloosa, AL (8) University of South Carolina Upstate, Spartanburg, SC



## Abstract

The Genomics Education Partnership (GEP) is a community of practice that supports faculty as they provide undergraduates a research experience in genomics. The GEP now has more than 250 members in over 200 undergraduate institutions across the United States, including Puerto Rico. Following in-person or virtual training, faculty claim annotation projects from one or more scientific projects (F Element Expansion, Pathways, Parasitoid Wasps); their participating students use empirical evidence (e.g., RNA-Seq data) and computational evidence (e.g., sequence alignments, gene predictions) to construct gene models. All annotation projects are completed at least twice independently. The results are reconciled by experienced students and used in comparative studies to address evolutionary genetic questions within each scientific project. To enable collaborating students and faculty to complete the research process directly (*i.e.*, without waiting for publication of the final scientific paper), we have created a workflow for submitting gene annotation papers to the journal microPublication. Because the databases, tools, and curricula are all accessible online, this research experience has remained available during the COVID-19 pandemic. While an “only online” format can be challenging, students reported similar personal gains (e.g., understanding the nature of science) and showed similar learning gains on pre/post knowledge quizzes. Thirty-three GEP members teach at community colleges. We find their students show gains similar to those achieved by all GEP students. The GEP is always looking to grow its faculty network and increase the diversity of the community; contact us at [thegep.org/contact](https://thegep.org/contact).

## CURES

- **Course-based Undergraduate Research Experiences**
- Undergraduate research available for **ALL**
- Defining characteristics:
  - Element of discovery
  - Iteration
  - High level of collaboration
  - Scientific practices learned
  - Broadly relevant topic (publishable or of general interest outside class)

## GEP goal and structure

- **Bring a genomics research experience into the academic year curriculum**
- A common platform
  - Parallel projects for students
    - Facilitates discussion/collaboration
  - Technically simple; genome browsers
- Jointly developed curriculum
  - Conceptually accessible for students
- Collaborative publication
  - Individual projects assembled into a whole for meta-analysis
- **Projects based on online resources** can be accessible to all institutions under many adverse conditions (pandemics, adverse weather, dispersed students, etc.)

## Future Directions

### Potential future projects:

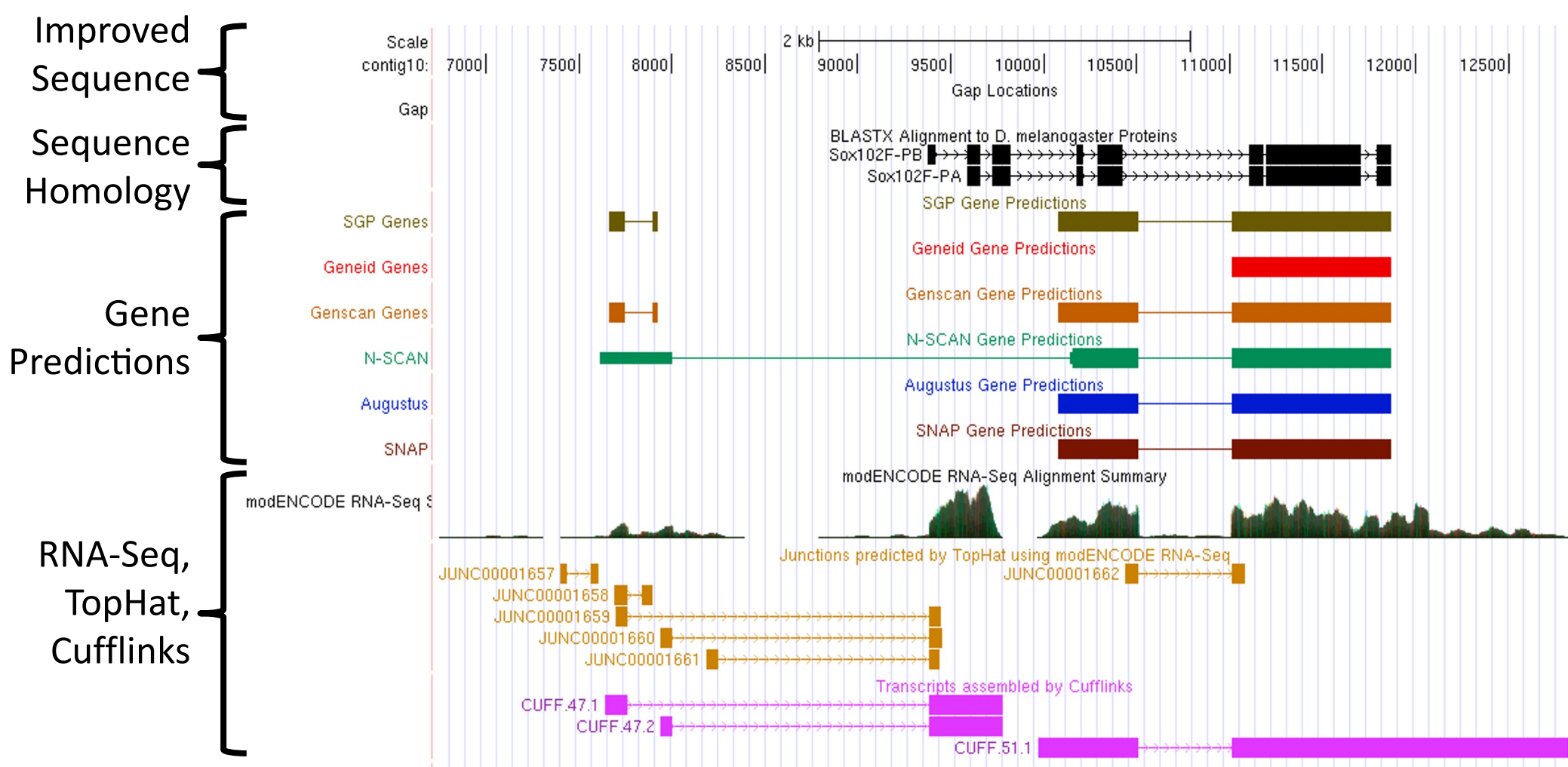
- TSS annotation
- Functional annotation
- Repeat evolution

### Interested in joining?



[thegep.org/contact](https://thegep.org/contact)

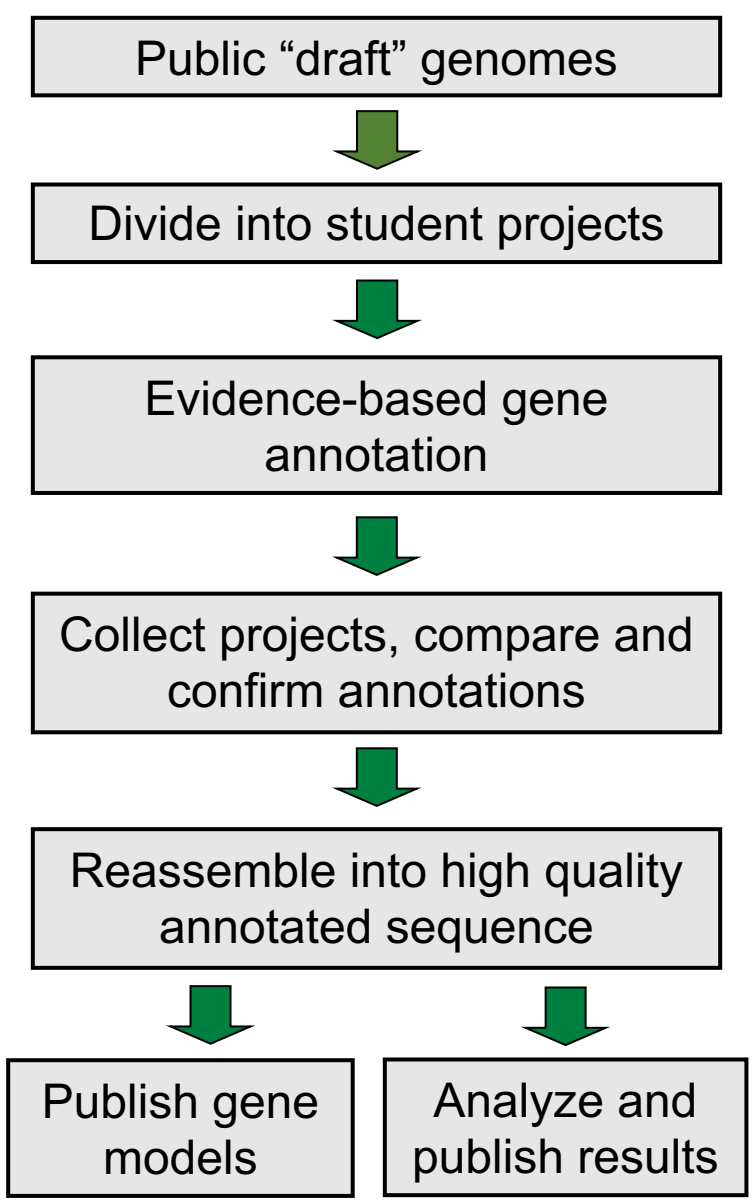
## Core strategy — the annotation challenge



Students annotate genes using appropriate evidence tracks in a genome browser

## Workflow

- Students learn to use
  - UCSC Genome Browser
  - BLAST
  - FlyBase
  - other tools
- Students
  - prepare formal reports
  - defend their conclusions
  - present posters, talks

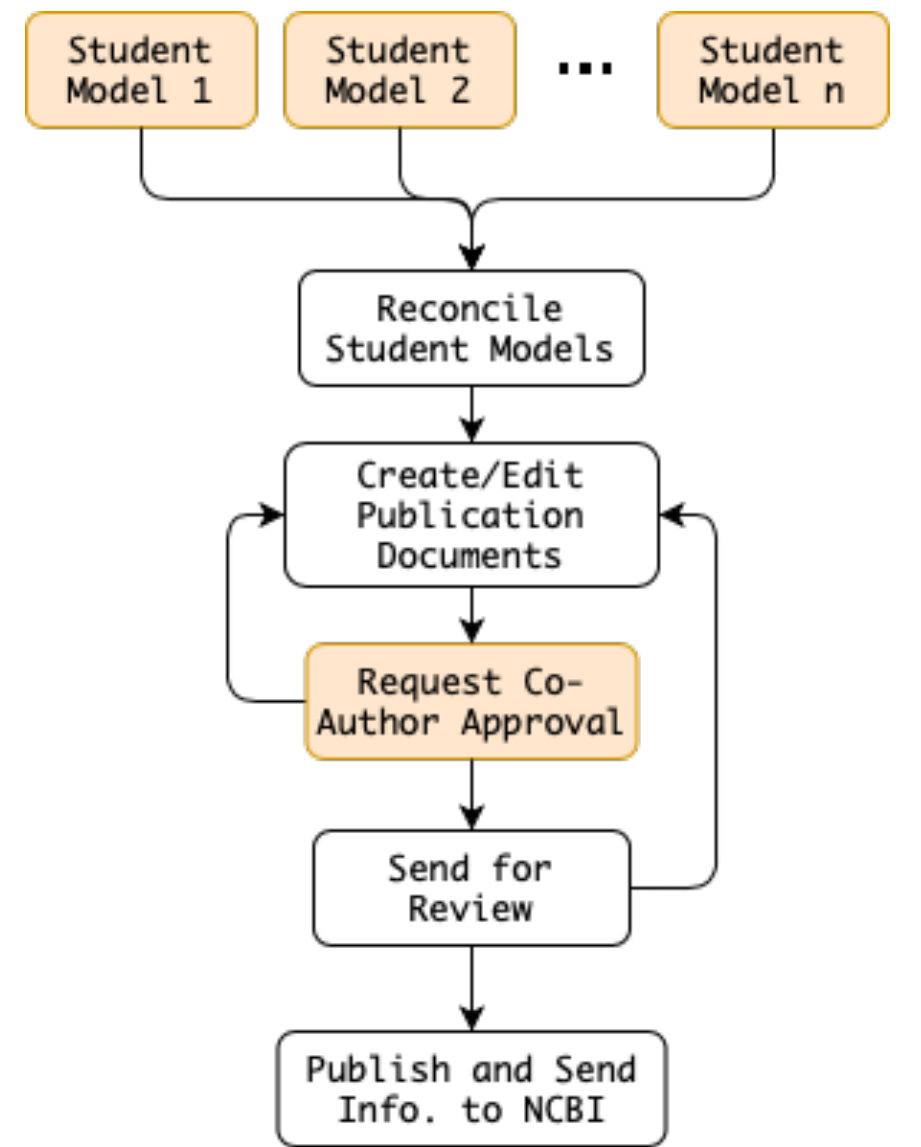


## microPublications



μPub mission fits gene models very well:

- 1 μPub = 1 gene model
- Standardized format
- Progress to date:
  - 5 models published
  - 20 submitted
  - 228 in progress



## Current science projects

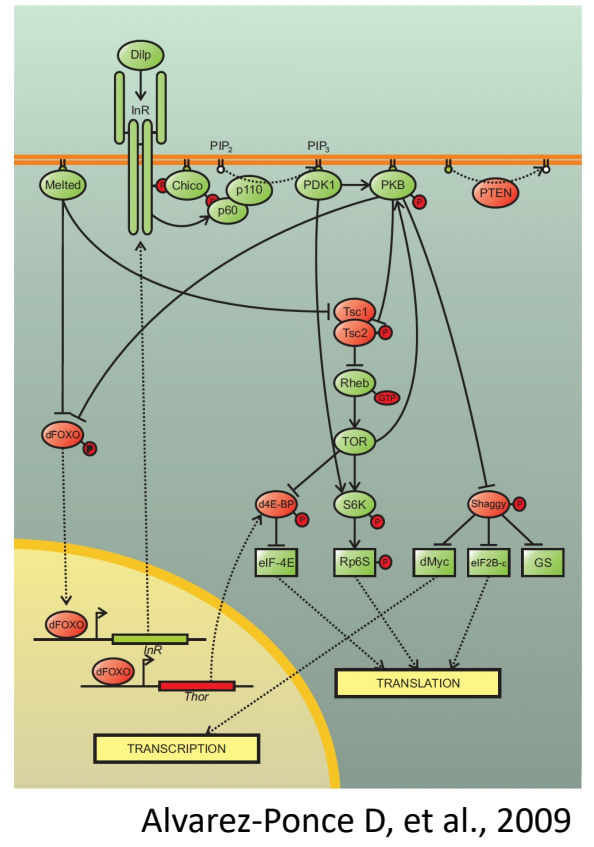
### Pathways Project (Laura Reed):



How does network structure influence and reflect the process of evolution?

#### Insulin signaling pathway

- Looking at genes in 31 *Drosophila* species
- Find rate of protein evolution is greatest at the “top” of the pathway
- Project will expand to other pathways in the future



### F Element Project (Cindy Arrigo, Chris Ellison, Sarah Elgin):

How does a heterochromatic environment impact gene and chromosome evolution?

#### *D. ananassae* F element expanded ~20-fold by TE's

- Find large genes, low codon bias



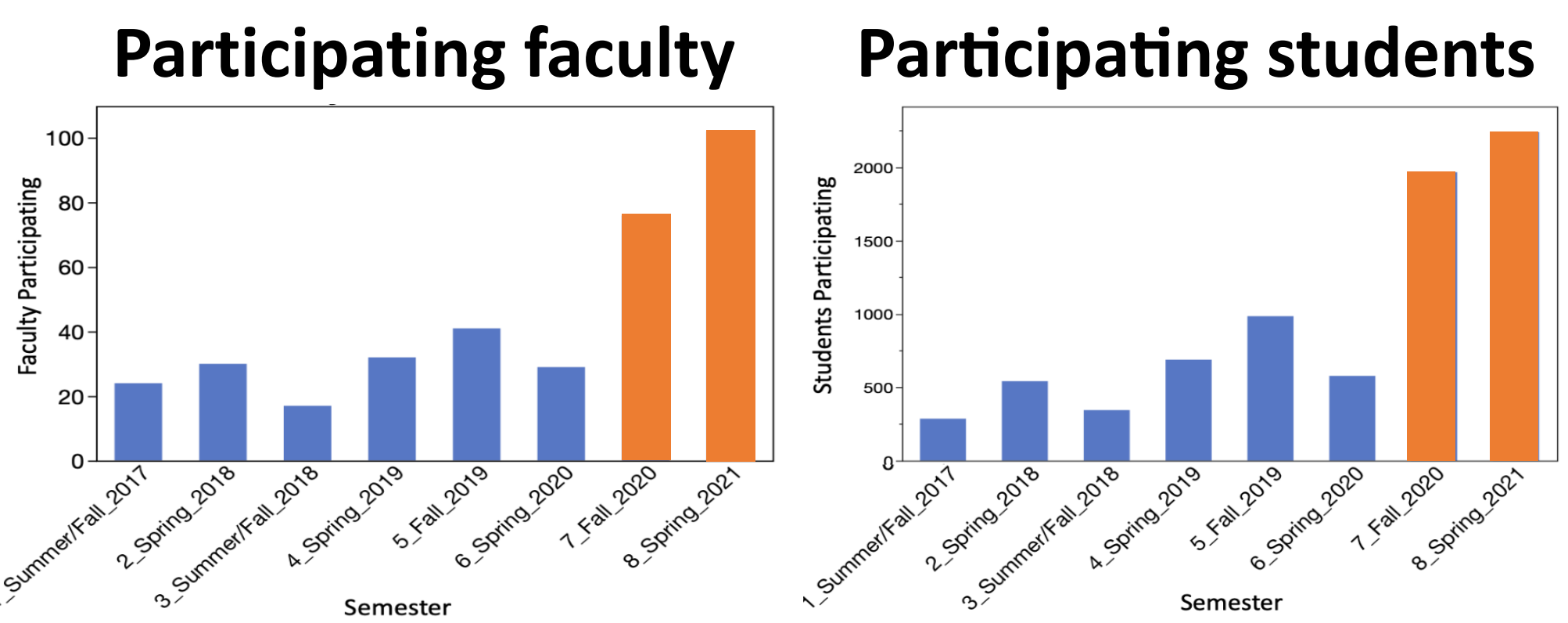
### Parasitoid Wasps Project (Nate Mortimer):

Evolution of venom proteins and signaling pathways

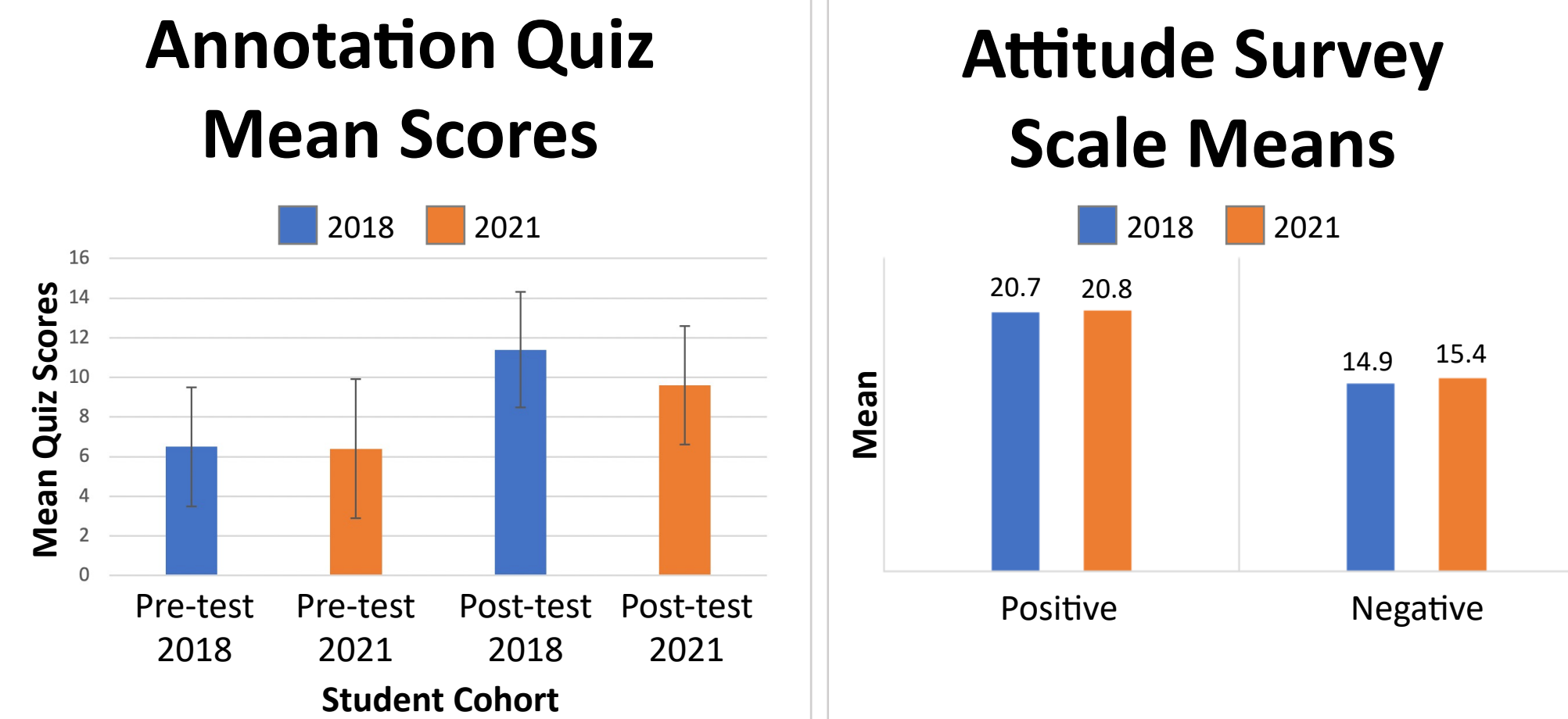


## During COVID...

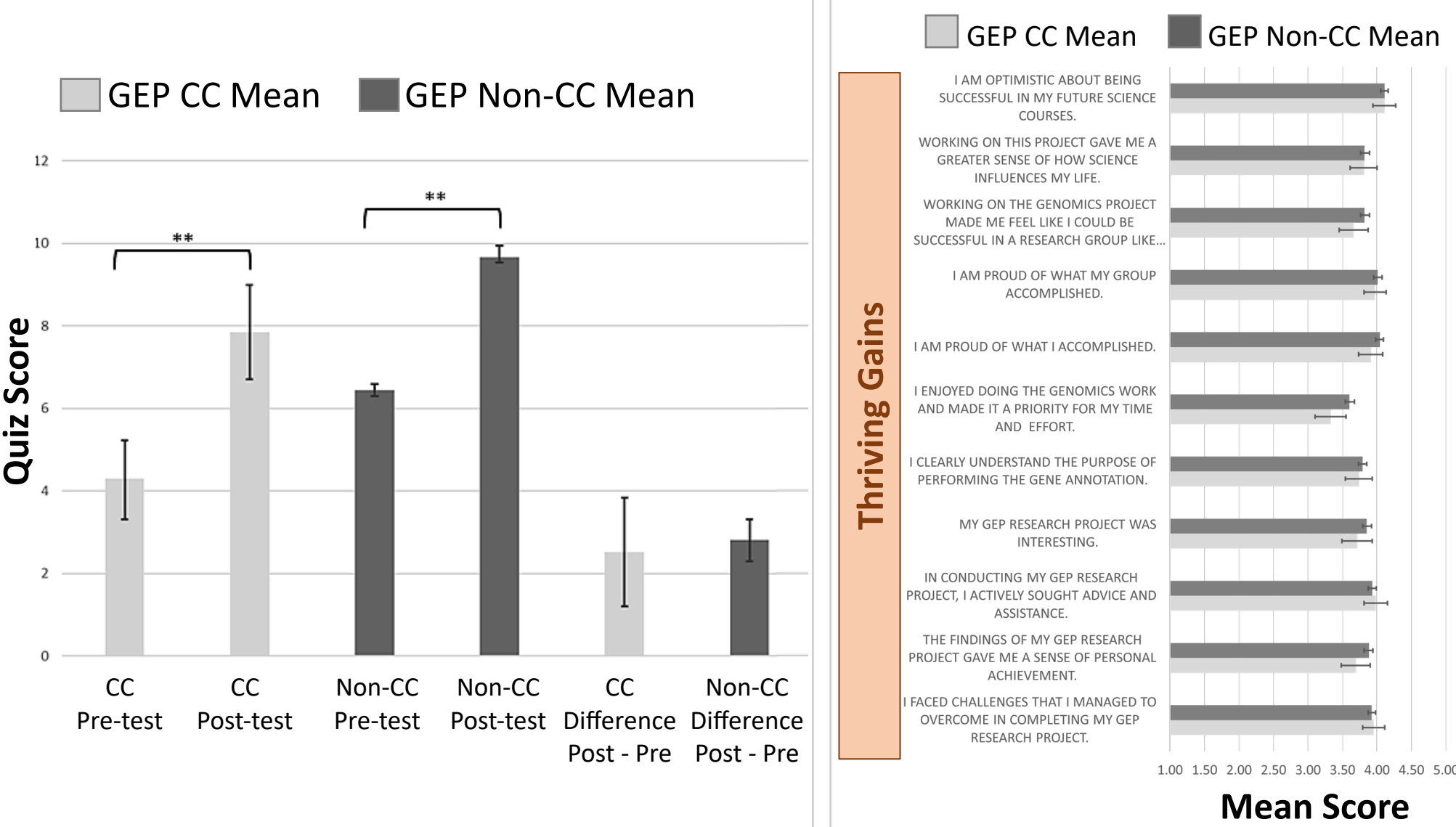
### ... participation doubled



### ... student learning did not suffer



## Community college (CC) and non-community college (Non-CC) students show comparable learning and thriving gains using the GEP curriculum



## Summary

- Students engage in research, while learning gene structure and genomics.
- Students publish gene models determined in a collaborative process.
- GEP projects were used successfully during remote instruction, allowing faculty to provide students with a successful, genuine research experience.
- Community College (CC) students benefit equally, suggesting more needs to be done to provide research experiences for these students.

## Acknowledgements

This poster is based upon work supported by the National Science Foundation under Grant No. 1915544 and National Institute of General Medical Sciences of the National Institutes of Health under award number R25GM130517 to the Genomics Education Partnership.

<https://thegep.org>