CBE Life Sciences Education

Evidence-Based Teaching Guide: Graphing in Biology

Stephanie M. Gardner, Aakanksha Angra, and Joseph A. Harsh

INSTRUCTOR CHECKLIST – GRAPHING IN BIOLOGY

The following summarizes literature-based recommendations for implementing graphing in the college classroom. Summaries of the articles leading to these recommendations can be found in the LSE Feature: Evidence-Based Teaching Guides.

SELECTING VARIOUS STRATEGIES UNDERLYING GRAPHING AND ASSESSMENTS TO SUPPORT LEARNING GOALS

- ❑ Building a classroom community around graphing. The inclusive teaching guide outlines teaching practices that enrich the classroom environment and provide insight into student-teacher interactions that promote success for all students. Below are practical strategies that you can employ to make graphing inclusive and explicit in your classroom from the beginning of the semester.
  - In the first week of class, create a graphing icebreaker activity where each student introduces themselves and their favorite type of graphical representation. As the instructor, you can go first and model your favorite graph and explain why it is your favorite. You may also consider extending the icebreaker and using Charty Party, graphs from the Dear Data Project, or graphs from social media.
  - Ask students about why they think graphing is an important skill, and what their personal learning goals are for this skill. Opening the dialogue and giving students a chance to explain why they think graphing is important can help you explain how you will help students reach their goals in the class.
  - Have graphing assignments on the syllabus. Students will be more open to learning from graphs and developing critical thinking if there is a grade attached.
- ❑ Understand the types of graphs your students encounter in the classroom and set expectations accordingly. Studies have shown that graph types, data displayed, and mechanics that are present in textbooks and primary literature vary in quality. Instructors can critique the graphs presented in learning resources to set expectations and as a teaching opportunity.
- ❑ Use topics to generate interest. Students encounter graphs in a variety of contexts. Instructors can use graphs that are of interest to their students to generate interest around graphing, starting with critiquing graphs SAGE Data Literacy Module.
- ❑ Determine your learning goals and specific learning objectives. Identify and articulate measurable learning outcomes that incorporate graphing skills to guide assessment and instructional design. You may want to consult the Vision and Change, BioSkills Guide, and Advancing Competencies in Experimentation (ACE-BIO) documents for targeted objectives. We also recommend asking yourself the following questions:
  - Do you understand what your students bring to your classroom related to graphing competence?
  - What do you want the students to know and be able to do? Is it observable and measurable?
  - Can these objectives be achieved through graphing? If so, which facets of graphing (e.g., constructing, interpreting, and critiquing) are applicable?

- ❑ Determine the assessment and frequency. Consider multiple assessments that align with learning objectives and engage students in one or multiple facets of graphing (e.g., constructing, interpreting, and critiquing) to build confidence and competency. It is recommended that students are given multiple and frequent assessments with instructor feedback to improve their graphing skills.
- ❑ Select specific activities that align with learning goals. Design or select activities that align with course learning objectives.

DESIGN PRINCIPLES FOR TEACHING GRAPHING

- ❑ Teach graphing grounded in the discipline. Graphing is not unique to biology; however, the systems under study, the study designs, data collection strategies, sources of variation and error, and the making of claims from data are deeply tied to the discipline. Determine which graphs can benefit from explicit instruction.
- ❑ Explicitly discuss graphs in the classroom. Pause to discuss graphs as they are encountered in the classroom, especially focusing on connecting the mechanical components of graph construction to the interpretation of the graph. Modeling how to interpret graphs can draw students' attention to their knowledge and expectations about the biological variables in a graph, knowledge and evaluation of graph types, and visual features of graphs. Over time, challenge students to explain and critique graphs as encountered in the classroom.
- ❑ Scaffold graphing practices. Providing students with stepwise approaches to creating graphs by hand or via graphing software and reading graphs can benefit students by breaking down the graphing activities into parts. It also can serve to remind students of the relevant steps to take along the way in creating and reading graphs. Over the course of the semester, students can be engaged in increasingly complex graphing tasks.
- ❑ Use data that engages students. Allowing students to select data. Have students collect and analyze self-generated data. Instructors can use problems or contexts that connect students to the data based on relevance or potential interest.
- ❑ Use real-world messy data. Engaging students with real-world messy data during data analysis, including constructing and reading graphs, will support students' understanding of the true nature of biology and provide them with the opportunity to further develop their quantitative reasoning and critical thinking.
- ❑ Utilize collaborative work. Allowing students to work together during the collection, analysis, and/or interpretation of data can not only improve their collaboration and communication skills but allows them to practice biology as it is done by research scientists. Students must negotiate differences of opinion and ideas and come to a collective understanding of what the data they are working with mean.
- ❑ Incorporate reflection. Prompting students to reflect on their choices during the creation of graphs and also when reading and interpreting graphs will promote a deeper understanding of biological data, inquiry and experimentation, and promote a valuable critical disposition that will serve them in biology courses and as citizens.