

Using Scientific Purposes to Improve Student Writing & Understanding in Undergraduate Biology Project-Based Laboratories

MELISSA KOSINSKI-COLLINS,
SUSANNAH GORDON-MESSER

Image: © Christopher Nuzzaco | Dreamstime.com

ABSTRACT

Understanding the scientific reasoning behind a laboratory procedure is critical to the student's understanding of the scientific process and has become increasingly important. In the introductory project-based laboratory curriculum at Brandeis University, we ask our students to write true scientific purposes for each laboratory in place of learning objectives. With discussion, feedback, and practice, we find that this simple exercise increases our students' understanding of the material and their ability to write abstracts and solidifies the underlying connections between multiweek procedures.

Key Words: Undergraduate; biology; laboratories; purpose; project-based.

Several important studies have emphasized the need for curricular change in undergraduate laboratories and lectures such that students can begin to understand the biological concepts amid torrents of seemingly unrelated facts (Howard Hughes Medical Institute, 1996; National Science Foundation, 1996; National Research Council, 2003). In response to these reports, it has been suggested that college-level laboratories be changed from “cookbook,” isolated protocols to multi-day, project-based procedures to help students understand the true nature of the scientific process and increase their overall understanding of the multistep, sequential nature of research (National Science Teachers Association, 2001).

Over the past 4 years our two-semester introductory biology laboratory series has been renovated to consist of multiweek project-based labs in genetics, biochemistry, and bioinformatics. The students no longer perform single-day experiments that conclude with predictable results meant to simply familiarize them with various techniques. They now design their own proteins and perform their own genetic and genomic screens. Our students still enter lab expecting to “learn how to use” pieces of equipment like thermocyclers or fluorimeters. Although these are part of our teaching objectives, during the first few years of these course changes our students seemed to lose sight of the relevance of the research and could not understand which integrated biological concepts governed their bench research. We remedied this problem by having our students write a brief “purpose statement” for each lab. The students are asked to explain the “who, what, where, when, why, and how” of the science of the overall laboratory procedure in one or

Students begin to understand and focus on the concepts behind the labs.

two sentences based on their reading of the protocol and background in advance of the laboratory session. The lab TA goes over the purpose before the students begin their experiments, stressing the “why” of the protocol in these discussions.

We have found that assigning scientific “purposes” helps our students in many aspects of the lab course. At the beginning of the class, we receive purposes for the initial labs that include such statements as “to understand how to perform SDS-PAGE” which transition into “purifying and characterizing mutant crystallin protein.” Students begin to understand and focus on the concepts behind the labs. In addition, by emphasizing the “why” behind each week’s exper-

iment, the students see that our several-week experiments have a single scientific goal. For instance, when the students are performing a *Drosophila* genetic screen over 11 weeks, they see that the goal of each day is always “to identify an enhancer or suppressor of the (same gene)” no matter where they are in the overall process.

The writing of purpose statements has also helped our students improve the quality of their scientific abstracts. Students often have difficulty writing a cohesive abstract for a final report that may encompass several weeks’ worth of laboratory procedures. Forcing students to write purpose statements for each lab ensures that they are clear on the concepts for both the individual lab and how everything fits together in a total semester-long picture. It further helps them formulate strong experimental question statements that inevitably make up the core of a well-written abstract.

In order to use purposes effectively, we have found the following practices useful. In a multisection lab course with several TAs, it is important that all staff agree on a single purpose and proper wording for the statement. In addition, it is important to give the students adequate feedback about what they have written by critiquing each week’s purpose and discussing it at the beginning of each class.

Our students’ ability to write abstracts, their conceptual understanding of laboratory procedures, and their ability to identify the scientific rationale that connects multiweek experiments have all been greatly improved by the integration of scientific purposes into our curriculum. We feel that this minor change may be useful for other project-based laboratory courses.

References

- Howard Hughes Medical Institute. (1996). *Beyond Bio 101: The Transformation of Undergraduate Biology Education*. Available online at <http://www.hhmi.org/BeyondBio101>.
- National Research Council. (2003). *BIO 2010: Transforming Undergraduate Education for Future Research Biologists*. Washington, DC: National Academies Press.
- National Science Foundation. (1996). *Shaping the Future*. Washington, DC: National Science Foundation.

National Science Teachers Association. (2001). *Practicing Science: The Investigative Approach in College Science Teaching*. Arlington, VA: NSTA Press.

MELISSA KOSINSKI-COLLINS (kosinski@brandeis.edu) is Assistant Professor of Biology and SUSANNAH GORDON-MESSER (sgmesser@brandeis.edu) is a graduate student in Biophysics and Structural Biology at Brandeis University, 415 South Street, Waltham, MA 02454.

NABT AFFILIATE MEMBERS

Biology Teachers Association of New Jersey
Cleveland Regional Association of Biologists
Colorado Biology Teachers Association
Connecticut Association of Biology Teachers
Delaware Association of Biology Teachers
Empire State Association of Two-Year College Biologists
Hong Kong Association of Biology Teachers
Illinois Association of Biology Teachers
Illinois Association of Community College Biologists
Indiana Association of Biology Teachers
Kansas Association of Biology Teachers
Louisiana Association of Biology Educators
Massachusetts Association of Biology Teachers
Michigan Association of Biology Teachers
Mississippi Association of Biology Educators
New York Biology Teachers Association
South Carolina Association of Biology Teachers
Texas Association of Biology Teachers
Virginia Association of Biology Teachers
Western Pennsylvania Biology Teachers Association

Thank You

The National Association of Biology Teachers thanks its affiliate organizations for their support & for their efforts to further biology & life science education.

ATTENTION TEACHERS! NEW ONLINE DEGREE PROGRAM OFFERED!

MASTER OF SCIENCE IN GENERAL BIOLOGY

Designed for K-12 teachers, this 33-hour program is taught online* and can be completed in two years.

Learn from faculty in the Department of Biological Sciences. Join students from around the world to earn a Master of Science degree through distance learning from Mississippi State University!

*The final capstone course is 8-10 days on location.

MSU is an equal opportunity employer.

Teachers in Biology

For more information, visit:
www.distance.msstate.edu/tib
or contact:
jbailey@aoce.msstate.edu
662.325.9684

Mississippi State University is fully accredited by the Southern Association of Colleges and Schools (SACS). Prospective students should check with the Department of Education in their states for local certification policies.

Mississippi State
UNIVERSITY
Division of Academic Outreach
& Continuing Education