

Professional Lab Notebooks: An Introductory Research Lab Course

Educator: Jason Fuller, Instructor, Biology and Environmental Science

Context: Out of class; BIO 211 – General Biology

Keywords: lab reflection, research experience

Student Activity Time: 1- 1.5 hours, 4 times per term

In a lab course, students were asked to reflect on their understanding of research science, lab protocols, data collection, and data analysis skills throughout the term and in preparation for the final course project.

Introducing the Reflection Activity

In an introductory biology lab course, an educator designed an opportunity for students to learn traditional lab techniques while applying their work to a real research problem. The educator developed four reflection activities to support the learning objectives of each unit. The purpose of these activities was to support students' mastery of fundamental lab techniques while developing scientific research skills.

In the eastern region of Washington, a soil fungus named *Gaeumannomyces graminis* var. *tritici* attacks wheat roots causing a harmful disease called Take-all that has the capability of destroying wheat crops. Soil bacteria can naturally reduce Take-all, but mitigation can take up to 10 years to occur. To aid farmers in this region, researchers have explored the relationship between the fungus, wheat and species of the soil bacterium *Pseudomonas fluorescens*. Current research has focused on sequencing the genome of various strains of the bacterium to understand what allows them to grow in association with wheat and thus reduce the impacts of the pathogenic fungus. This current unresolved scientific problem has negative economic impacts. An educator used this research problem to frame the introductory biology lab course.

The lab course was designed in four units, each with an associated reflection activity. In the first unit, students learned basic sequence analysis, how to use DNA databases, collect bacterial cultures, and other fundamental procedures. While developing these skills students also learned to keep a laboratory notebook and read scientific articles. The first reflection activity for the term prompted students to reflect on their understanding of the project thus far, their role in the project, and their understanding of scientific research.

In the next unit of the course, the educator assigned each lab group a DNA insert from a particular strain of soil bacterium for sequencing. After completing the assigned series of protocols to prepare their DNA to be sequenced, students were prompted to reflect on their implementation of each protocol, documentation in the

process, and a self-assessment of their structured lab notebooks. Students were also prompted to identify any challenges that arose in the preparation of their DNA. The third unit was focused on analysis of their DNA sequence data. In their lab notebooks students were prompted to label their assessment of the quality of their data, and their explanations of the significance of their data in relation to the overall project. This activity was followed by another self-assessment and reflection about their data documentation processes in comparison to the scientific research papers they read throughout the term.

The fourth unit was a full project reflection that prepared students to complete their poster of the entire project. The prompts in the final reflection required an additional review of students' lab notebooks, and the full experience of the genomics research project and the journal club. Students were asked to reflect on their ability to collect, document, analyze, and present scientific information as researchers.

The purpose of the unit reflections in this course was to guide students through the detailed process of understanding, documenting, and analyzing real scientific data in order to present their findings as professional research scientists. The reflection activities supported a wide range of outcomes including content knowledge, identity as a scientist, and preparation to pursue scientific research in the future.

Recreating the Reflection Activity

	Description
1	Introduce students to the entire research project at the beginning of the term.
2	Assign unit reflections after the associated unit has been completed.
3	Collect, grade and return each unit reflection.

**DIGITAL
LIBRARY
CONTENT**

 7.1 Biology 211:
Professional Lab
Notebook

In the words of the Educator: Tips and Inspiration

Expect revision, but remain encouraged. If you put together something like this expect revision after revision. There are things that I would like to work better the next time. For this activity, there are parts where the instructions aren't very clear so that can be improved the next time. Another option is to do the self-assessment and reflection separately from the activity itself. In some instances, the level of detail is not enough, or in some cases it is too much, almost making the reflection like a checklist. I don't plan on going back to the old way of doing lab notebooks because this process is much quicker and easier. I'm not looking for mistakes in the way that I would before, so taking the time to work through the changes will make the process even better.

Introduce students to the idea of self-assessment and reflection. Students have probably never done anything like this, so the way you present the concept

of self-assessment and reflection is important. In the beginning you want to communicate your expectations, and walk them through the process so that they can adjust successfully.

What was the inspiration for the reflection activity? The desire to put it together really came from two things. First, grading the old lab notebook format took a lot of time and was really painful for me. This format is much easier to grade; I can turn their notebooks around faster and give more meaningful comments to students. The other part was that in the past I had a relatively small number of students who put together exceptional lab notebooks. I wanted to increase that share of quality lab notebooks in the class and I also knew that a good number of students weren't figuring out how the lab notebook worked. This new format helps them understand it faster, and the number of students who are struggling to understand goes down a lot. The additional instructions and self-assessment make a big difference for students.

I worked on this with Robin Jeffers, who is now retired, but a self-assessment guru while she was here. She helped develop the larger research project and the self-assessments for this lab. We talked about what needed to be in the lab notebook, what sections it should be divided into, and she put together most of the questions in the actual activity. She was able to turn this into an activity for students to do and think about their work, instead of it just being something that they just turned in.