

# The Pros and Cons of Electronic Laboratory Notebook Use in Undergraduate Courses

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## Extended Abstract

Notebooks are an important component of any laboratory experience, but the logistics of grading laboratory notebooks can be a problem. Some of the problems with paper notebooks are the loss of notebook, reviewing teaching assistant's comments to the students in a timely manner, reading handwritten notes, and embedding figures and images into the lab notebook. Electronic lab notebooks provide a solution while serendipitously increasing student interest. Students with electronic lab notebooks were able to more easily share with lab partners for better assignment completion, while simplifying progress monitoring and grading.

Online notebook use develops skills translatable to many careers requiring online data management systems. Electronic laboratory notebooks have been used successfully for multiple quarters in a large upper division laboratory course with multiple sections. Students overwhelmingly prefer the electronic notebook to the paper one. Electronic notebooks facilitate creativity by allowing inclusion of multimedia, links, safety data, protocols and other metadata. Students were more reflective and had more practice in quality writing. Electronic notebooks provided real time and any time in monitoring of student progress, without ever removing access from the student, TA or instructor. Grading is easier due to full accessibility, more effective searching, and much better legibility. Electronic notebooks are not easily lost. TA comments can be as easily reviewed allowing better class management. This session described the successes and challenges of managing and implementing electronic notebooks. Participants used the SparkLix, an available free electronic laboratory notebook program during the session.

- SparkLix was the electronic lab notebook used in the *Developmental and Cell Biology Laboratory* course. The *Developmental and Cell Biology Laboratory* course is offered four times a year with seven lab sections each containing twenty four students. A standardized organization and setup of the online notebook is a necessary step to ensure implementation and ease of use. The following organization scheme was used:
- All lab experiments were separate experimental pages under a project folder, *My Project*.
- Each student created a *My Project* with the title which included the course quarter, the lab session time and the student's full name. Instructors can easily search for the lab notebooks from a particular lab section because of the uniformity of the naming the *My Projects*. A text box in the *My Project* page allows students to add information about their bench location and lab partners.
- Students must invite the instructor and their teaching assistant as a colleague to the *My Project* folder.
- Each lab *My Experiment* will have multiple pages that will contain information about each lab. Having a common format will help both the teaching assistant and instructor grade the lab notebook in a timely manner. Each *My Experiment* subfolder has individual pages that include specific information.
- *Page One* includes information about goals, anticipated outcomes for the experiment, materials, and methods and any additional information about the experimental design. Students should complete most of page one before the lab begins. Any changes made to the materials or procedure from the handout for the experiment should be highlighted. Students are asked to explain why they make changes in the procedure.
- *Page Two* is devoted to the results from the experiment. The first section of page two should contain information about the controls used in the experiment and why they were included. The second section contains the raw data and observations.
- Images from the experiment are organized on *Page Three*. One of the grading rubrics for the lab notebooks deals with the quality of the figure legends for each of the included images. SparkLix has a comment text box under each image or figure uploaded that can be used by students to create their figure legends. Images can be uploaded to

the online notebook using any device with an internet connection. The *Developmental and Cell Biology Laboratory* has a CCD camera that allows students to take microscope images and then directly upload them to their lab notebook. Students have also used their cell phones to take images through the ocular lens of their microscopes. Handwritten notes can also be included in the lab notebook simply by taking a photo using a cell phone and then uploading that image to the notebook.

- *Page Four* is devoted to the students' discussion of their results, the assessment of their errors, and changes they would make if they were to repeat the experiment.
- *Page Five* contains the answers to the post lab questions.

The students are given a general lab notebook rubric at the beginning of the class and a specific rubric is available to the students for each week's lab notebook. Because the lab notebook is an important component of the course, 36 percent of the total points in the class are allocated to the lab notebook. Students are required to complete their lab notebook within two days from the completion of their lab. Since the lab notebook is available to all instructors at anytime, real-time feedback can be given to the students and graduate assistants. If the instructor cannot be present for a lab section, they can review the students' notebooks and see what problems may need to be addressed before the next lab section.

Because of the success of the lab notebooks in the biology labs, the chemistry labs are now implementing an online lab notebook. The Chemistry department has decided to use a paid version of the lab notebook offered by LabArchives in their lab courses to help with the implementation for a larger number of students.

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