The Advantages of Electronic Laboratory Notebook Use in your Laboratory Classroom and the Benefits of Lab Courseware Migration

Abstract

Laboratory Notebooks are an important component and vital tool in the laboratory classroom, where observations, experiments and results are recorded. For hundreds of years, lab students have employed paper notebooks to maintain their research data and information, but with improved technology and the evolution of data from analog to digital, there has been a migration to digital versions. Electronic Lab Notebooks (ELN) provide an overall digital management solution, while allowing the teachers and TAs to manage, engage, monitor and evaluate their students lab work, all at a lower cost than a traditional paper lab notebook and in real-time.

Electronic lab notebooks have proven to increase student interest, engagement and overall performance in the lab. Results show that students who use electronic lab notebooks are more likely to share with lab partners for better assignment completion; at the same time enhancing the instructor/TA to student communication process, progress monitoring and grading. Additionally, students come to lab more prepared so that more work can be done, and instructors have reported an improvement in lab reports. No more collecting, storing, and distributing paper notebooks.

With the movement from paper to digital, lab classrooms around the world have been experiencing the benefits of upgrading to digital technologies. ELN’s can also be used as a digital publishing platform for course content. Instructors have seen the benefits of migrating the publication of their courseware (i.e. lab manual) to within the ELN to create a hybrid lab manual and lab notebook, taking a fraction of the time, cost and effort required to produce traditional paper courseware, while allowing for updates or corrections to content at any time during the course.

To help demonstrate how quick and easy it is to use your existing course assets to create, publish, monitor and grade your lab courses with a simple change from paper to an ELN, we will cover the full life cycle of a course as viewed by both the instructor and their students.

Background

LabArchives was founded in 2009 by a team of experts in the development of scientific and academic software for the higher-education community. Previous products produced by our team include Reference Manager, the first bibliographic management software, Reference Update, the first digital current awareness service for biomedical researchers, RefWorks, the first web-based bibliographic management software, and GraphPad Prism, the leading scientific curve fitting, statistics and data analysis software.

What is LabArchives?

LabArchives is a web-based collaborative tool that was specifically designed for the storage, organization, sharing, and publishing of research data. A highly secure solution, LabArchives provides a simple tool to be used by researchers around the globe to manage their data and to protect the intellectual property rights of their respective institution. Using the same core platform, LabArchives electronic lab notebook (ELN) has also been adapted for use in an educational setting. Classroom Edition
is widely used to train undergraduates in the proper application of the scientific method using the latest technological tools while also greatly improving the efficiency of the teaching process. This provides teachers and TAs with the ability to manage, engage, monitor and evaluate their student’s lab work in 24/7 real-time, all at a lower cost than a paper lab notebook.

The objective of this article will be to provide the framework for instructors to improve student record keeping, while better preparing their chemistry students for college, and careers in STEM fields. We will show how easy it is to use existing course materials and digital assets to create custom notebooks for each of your students.

Electronic laboratory notebooks have been used successfully for multiple years in hundreds of biology, chemistry, engineering, and physics lab courses. Survey results show that students overwhelmingly prefer the electronic notebook to paper, because they allow for easier data sharing and increased versatility. Electronic notebooks facilitate creativity by allowing inclusion of multimedia, links, safety data, protocols and other metadata. Students are found to be more reflective, show up to lab better prepared and get more quality practice in writing. Electronic notebooks provide real time, any time monitoring of student progress, without ever removing access from the student, TA or instructor. Communicating with students and grading is easier due to work always being accessible and easily referenced, with more effective search capabilities and much better legibility. Electronic notebooks are not easily lost. Student, Instructor and TA comments can easily be reviewed allowing better class management. At the end of the article, participants will be given the opportunity to create their own free instructor account.

Real World Results from Dr. Michelle Driessen,

Associate Professor and Director of General Chemistry at the University of Minnesota

Paper-To-Digital ELN

I can see how my students are filling out their notebooks in real time, and also creates an archive of student data for future reference.

I can see how my TAs are grading and commenting.

Cheaper by nearly 50% from the duplicating notebooks we used to use and no more lost paper.

No more lost notebooks or missing data when a lab partner drops since sharing data is possible (at instructor discretion).

Extremely easy set-up and maintenance for instructor, very easy for students and TAs to pick up.

Time stamps stop students from going home and writing their notebooks “neatly” rather than actually taking notes in the notebook during lab.

Student grouping functions and speed grading are very nice and make course management much easier than paper notebooks.
**Digital Course Lab Manual**

Extremely simple migration of my lab courseware from Word docs and existing website content to LabArchives notebook. It took me around 3 hours to copy/paste move all of my lab manual content to the LA format, once I knew the best practice.

I view this as a flexible digital publishing format that allows me to update and fix errors nearly instantaneously.

Nearly my entire lab course is in the LA notebook – students know where to find everything.

LA is integrating most software that a gen chem student would need: Word, Excel, PPT, LoggerPro, ChemDoodle, etc...

**Flipped Classroom**

I use the ELN as a digital workbook in my Active Learning/Flipped Classroom. I paste all of my in-class activities into the ELN and the students enter their answers while working in class.

**Objectives of the Video Below**

The following video will provide a brief demonstration detailing how simple and effective it is to use your existing course assets (like your lab manual, handouts, and lab reports) to create your own digital master course notebook. We will show how Instructors are provided with full control over the look and feel of their digital notebooks, and that notebooks can easily be customized to meet the instructional objectives of any lab course. You will learn how to launch your course, add teaching assistants and students, manage ongoing lab activities and lastly we will show you how your students will interact with their digital notebooks.

How does the Classroom Edition work? An instructor creates a Master Course notebook for the course which is then cloned or published to each student in the course, so that they are provided with their own exact copy of the notebook to work from. Master Notebooks can either be blank (much like a paper notebook) or content-rich, including all the assets for the course in the same location the students will be documenting their lab work.

Today we will be sharing a course notebook from Dr. Michelle Driessen, Associate Professor & Director of the General Chemistry Program at the University of Minnesota. This is her lab content for General Chemistry 1065 with close to 2500 enrolled students this fall. As you will see from her notebook, virtually all of her lab content has been incorporated into the lab notebook. Dr. Driessen’s content is available for licensing into your course, if interested please send inquiries to Jeremy Miller.
To watch a Demonstration video go to: http://vimeo.com/112576157

To create your own free instructor account, visit: Free Instructor Account

To add yourself as a student to this demo Chemistry 1065, visit: Chem1065 Student

LabArchives HOW-TO Instructions for Creation of Master Course Notebook and Creating a Course

Creating Folders and Pages

LabArchives uses a standard file system of Folders to organize your laboratory information. Each folder may contain any number of "sub-folders." There is no limit to the number or levels of sub-folders.

Your data is then stored on Pages; folders can contain an unlimited number of pages.
To add a Folder or a Page, simply place the cursor on the folder where you want to place the new object and right-click (Ctrl-click on the Mac) the mouse. A short menu will appear with the following options:

- Add New Folder
- Add New Page
- Copy Existing Page...
- Copy from another notebook...
- Rename item
- Delete item
- Undelete item
- Reload from server
- PDF...
- Share...
- Permissions...
- DOI...

Then select the desired option from this menu.

Finally, you will see a listing "Add new item.." below every Folder. This enables you to add a new Folder or Page without the need to right-click.

Folders and Pages may be moved at will by using standard "Drag and Drop" technology.

Note that Folders and Pages may be shared (with your group of Users, with colleagues, or with the entire world). A different icon is show to indicate which Folders and Pages are shared:

Unshared Folder: 🧮

Shared Folder: 🧮

Unshared Page: 📄

Shared Page: 📄
Editing Your Notebook

At any time, you can edit any Entries, folders, or pages in your Notebook. LabArchives automatically maintains all versions of every Entry, so you can view the history of your work, or have the option to revert to an older version.

Editing Entries

To edit an Entry, simply move the cursor over the Entry; when you are positioned over the Entry, it will change color and a menu will appear at the top:

- edit - delete - move - revisions - print - share ↓ ↑

Click the Edit link that appears at the top and you will be allowed to make any changes to any type of entry, just as you do when entering data.

Deleting

You may Delete an Entry by clicking on the Delete link that appears at the top when you move the cursor over the Entry. Because LabArchives stores every version of every Entry in perpetuity, you cannot actually remove something from your Notebook. It will always be there, and will appear whenever you view Revisions.

Moving

Any Entry can be moved to another Page in the Notebook by clicking on the move link that appears at the top when you move the cursor over the Entry. Doing this displays a menu of the Notebook structure. Select the page on which you want this entry to appear.

You can also add new Folders and Pages using the "add new item.." link that appears. Note that the entire history and all Revisions are maintained when you move an item.

Renaming Folders and Pages

You can rename any Folder or Page by right clicking the given folder/page in the notebook navigator, then click "Rename". Note that Folder and Page names are not considered to be "Data", and thus the history of these changes is not maintained by LabArchives.

Moving Entries within a Page

You can reorganize a Notebook Page by using the small arrow icons to move an Entry up or down within the Page. This will allow you change the sequence of a Page's appearance. Note that the entire history and all Revisions are maintained when you move an item.

Overview of Entry Types

Each notebook in LabArchives is organized by folders, pages, and entries. When you first create a notebook, you are given a set of default folders which you can name and move around within the notebook navigator as you want. A folder can contain any number of pages, and a page can contain any number of entries. Below is a brief overview of each entry:
**Rich Text:** The most commonly used data entry from our users. A word processor built into LabArchives as it allows special formatting, embedding images, uploading pictures, etc.

**Attachment:** LabArchives allows all types of files to be uploaded. This includes PDFs, images, MS Office files, GraphPad Prism files, and much more. The maximum size for the attachment is limited to 250MB and so if your data file is larger than this, it's best to provide a reference link from within your notebook.

**Office Document:** LabArchives includes a feature that enables you to create and edit MS Office compatible documents from within your notebook.

**Heading:** Allows you to divide a notebook page and makes it more readable and visually appealing.

**Plain Text:** Also a word processor like Rich Text, but does not contain any special attributes. Meant for simple text and for when devices or browsers do not support Rich Text entries.

**PubMed Ref:** LabArchives allows you to automatically import and store references from PubMed in your notebook. There will be a pop-up window to perform the search.

**Widgets:** Customizable apps or data forms that can be used for many purposes (ex. calculator, period table, data forms, etc).

### Creating a New Course

As an instructor, the Course Manager will be your number one tool for pushing out class content to your students, editing existing class content, monitoring student activity, grading student submissions, and organizing your students into separate sections and courses. If you have Teaching Assistants (TAs), they can be added to your course through the Course Manager and can take advantage of several of the tools as well.

The Course Manager contains four panels. Note that these panels will not be visible until you create at least one course.

- **Creating a New Course:** If you do not already have a course in your LabArchives account, then the Course Manager is not yet activated. You can activate it via the triple-bar icon in the upper right corner ( ), then select "Utilities", then "Course Manager...".

- **On the Course Manager page,** click the button. You will need to give your new course a title, and select a preexisting notebook on which to base your students' notebook. You may also add a course description if you wish. You can add a description for your course if you wish. After filling in all the proper fields, your screen should look something like this:
Click "Save Changes" to officially create your course.

After your course has been created, you can quickly access the Course Manager by clicking the icon in the upper right of any LabArchives page.

Notice the tabs above this panel. These represent your separate courses, and they are labeled with the course's name. You can flip through different courses by selecting one of these tabs.

### Adding Students and TAs

Once you have created your course and selected the notebook on which your students' notebooks will be based, you will want to add students and TAs to your course.

At this point, it is important to take a "snap shot" of your master notebook PRIOR to adding your new students. Click the button. Doing this becomes important if you plan to re-use master notebooks year after year. Not following this procedure will result in "old" course material mysteriously arriving in your students notebooks when you think you are updating with new material. Following the end of the semester, you most likely will clear out old assignments from the previous semester and add fresh material for the new students coming into the course. Before you add those new students, click the button. Now, add your students.

After you have activated your Course Manager by creating at least one course with a preexisting notebook, you are ready to begin adding students. This can be done either in the Student Sign-Up URLs panel, or the Edit Students and Teaching Assistants panel.

#### 1) Student Sign-up URLs:

- This panel gives you auto-generated links that your students can use to add themselves to your course. Simply disperse these links among your students as you see fit. Instructors often use BlackBoard to do this.
- Note that if you create multiple sections in your course (explained later in this article), there will be a separate URL for each section, and an additional URL for a students who will not be assigned a section. An image of this panel for a course with no sections appears below.
2) **Edit Students and Teaching Assistants:**
Here, you can add students as well as teaching assistants individually by email. While in the "Students" or "Teaching Assistants" tab, simply fill in the appropriate emails (separated by commas, enters, semicolons, etc.) in the text field, and click add when done. The recipients will get activation links that will allow them to add themselves to your course as a TA or student.

**Creating new sections** is done within the **Edit Sections** panel. Before you have any sections, the panel simply contains a message saying "Add Sections to this Course". Click this text, and the window shown below should appear:

- Give your section a name and a description (optional), and it will become functional once you save changes.
- Note that the sections for your course appear as tabs within the Edit Sections panel.
- New sections can be created by clicking the Plus Sign button next to the course tabs.
- An existing section can be deleted by clicking the X button within the given course tab.
When your Course First Begins

After you start to add students to your course, they will begin to populate the table in the "Students" tab of the 'Edit Students and Teaching assistants’ panel. Once a student has logged into the course notebook at least once, a notebook icon ( ) should appear in their row. So, when your course has filled with students, but no actions have been done in the course (i.e., in the first week), your "Students" tab should look something like this:

- Notice the name, email, section, number of activities, and time of last activity are listed for every student
- Clicking the notebook icon for a given student will allow you to see the notebook as they see it
- You can change the section of an individual student via the drop down menus in the "Section" column

Submitting new Content to your Students and Editing Existing Content:

Your students do not automatically see the changes you make to the course notebook. In order to "push out" any changes to the notebook (new assignments, edits to old ones, new schedule, etc.), you MUST click the button in the "Edit Course Information" tab. Notice a timestamp of the last time you did this appears next to the button. Be sure you are using this button consistently so that your students receive your desired content.

Observing Student Activity

After students begin making entries and submitting assignments, you will see notifications in the view column in the form of icons with red badges. An example of this table after all students have submitted one assignment appears below:
Notice that three other icons have appeared in the view column as a result of students taking further action. Let's go through these one by one:

- **Assignment Icon**: This icon directs the user to the activity feed if the badge value is different than one, or to the only new assignment if the badge value is equal to one.

- **Notification Icon**: This icon directs the user to the activity feed if the badge value is different than one, or to the only new entry/edit in the student's notebook if the badge value is equal to one.

- **Activity Feed Icon**: This icon unconditionally directs the user to the student's activity feed.

**Viewing Student Notebooks**

As was explained in Part 2 of Using the Course Manager, there are multiple icons that will guide you to a student's notebook. Once you are in a student's notebook, you will see a display similar to this:
While the content in the body of the page may be different, if you are viewing a student notebook you should be able to see the Assignment Navigator at top (yellow bar) and the Notebook Navigator banner should be highlighted in yellow.

- The Assignment Navigator allows the instructor to flip through the notebooks of multiple students within one section or within multiple sections. It also allows you to view the same assignment between different notebooks. This can be done via all the drop down menus within the assignment navigator, and with the yellow arrows in the upper left of the Assignment Navigator.

**Submitting Student Grades**

Once you have the student's assignment entry of interest in view, you can grade it by clicking the "edit" button that appears by mousing over the assignment entry. After clicking, switch the Assignment Status drop down menu to "Graded". Once this is done, you will be able to type whatever grade you want in the text field that appears. If the grade is for a group, a check box will appear that will allow you to choose whether you want to have the grade apply to the entire group. Be sure to click the "Save" button to finalize the grade.

**Viewing Student Grades**

Grades that you have submitted to students can be viewed in the "Grades" tab of the "Edit Students and Teaching Assistants" panel. Each Assignment has its own pair of columns: one for the actual grade, and one for the name of the Grader.

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Email</th>
<th>Section</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant, Fake</td>
<td><a href="mailto:faketa12345@gmail.com">faketa12345@gmail.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patrick</td>
<td><a href="mailto:fakestudent12345@gmail.com">fakestudent12345@gmail.com</a></td>
<td>Section 1</td>
<td>B</td>
</tr>
<tr>
<td>Student</td>
<td><a href="mailto:fakestudentnt23456@gmail.com">fakestudentnt23456@gmail.com</a></td>
<td>Section 1</td>
<td>A</td>
</tr>
<tr>
<td>Student</td>
<td><a href="mailto:fakestudent45678@gmail.com">fakestudent45678@gmail.com</a></td>
<td>Section 2</td>
<td>C</td>
</tr>
<tr>
<td>Student</td>
<td><a href="mailto:fakestudent34567@gmail.com">fakestudent34567@gmail.com</a></td>
<td>Section 2</td>
<td>D</td>
</tr>
</tbody>
</table>

Showing 1 to 5 of 5 entries
Closing your Course

Once your course is over, we recommend you close out your course, an option you will find under Edit Course Information in the Course Manager.

When you close out your course,

- Students are removed from the course and become owners of their notebooks; you no longer have access to their notebooks.
- The grades report for the course is erased.
- The end date that was on your course is cleared.

The **Close Out Course** button is found in the "Edit Course Information" panel of the Course Manager, as shown below.

Once you click that button, the following window appears:

You may chose at this time to remove TAs and/or Sections from this course by checking the appropriate box.
What if I want to save a record of student grades before closing a course?

If you want to save or export students' grades before closing your course, be sure to follow the directions as specified before proceeding to Close Out Course:

When ready, click the Close Out Course button.

After the course has been closed, the basic course information will be retained and ready to have new students/TAs entered.

Once your course comes to an end, it's probably a good idea to let students know what will happen with their notebooks. By becoming owners of their notebooks, they will gain access to two menu options under the Utilities menu: Notebook to PDF and Create Offline Notebook.

These options will allow the students to download permanent copies of their work in LabArchives, which they can later use as part of their ePortfolio.

What is the difference between "Close Out Course" and "Delete Course"?

- Closing out a course clears the student info, the grades, and clears the end date but gives you the option to retain the section and TA information, along with the basic course information.
- Deleting a course clears all information about the course with no option to retain any details about the course. Typically this would be used to delete a course if there was an error in the course creation process.