Report on Findings from a Survey of Electronic Lab Notebook Users at the University of Wisconsin-Madison

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Prepared by members of the Electronic Lab Notebook Service Team:

Trisha Adamus, Health Sciences Library
Ariel Andrea, General Library
Jan Cheetham, Division of Information Technology
Tobin Magle, General Library
Jason Pursian, College of Agriculture Life Sciences
Shannon Stiles, Division of Information Technology
Victoria Sutton, Wisconsin Alumni Research Foundation
Tom Tabone, College of Agriculture Life Sciences
Xin Xie, Division of Information Technology

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Executive Summary

In November 2018, the UW-Madison Electronic Lab Notebook (ELN) Service Team conducted a survey of users to understand the value of an enterprise ELN system, benefits and shortcomings of the LabArchives system, and the barriers to adoption of the ELN. The survey was completed by 147 respondents.

Respondents included active users (64%), i.e. those currently using LabArchives and non-users (36%), i.e. those who signed up for an account but either never used it or stopped using it. The following are key findings from the survey:

- A majority of users indicated they had been using LabArchives as the primary method of recording their research. Most users who were Principal Investigators (PI)s indicated their group had been using the ELN for more than two years; whereas, most non-PI users indicated they had been using it for one year or less. Additionally, most users indicated that several members of their research group were also using the ELN.
- Non-users reported using a wide variety of other tools for recording their research, with paper and Microsoft Office software listed most frequently.
- LabArchives users rated it higher than non-users rated their tools in three key areas: keeping a complete research record, producing a long-term archive of research, and sharing findings with collaborators.
- Other advantages noted by users include the ability for all lab members to access notebooks from any location, searchability, compatibility with multiple data formats, and ease of use. A majority of users indicated that they are able to attach/store 50% or more of the data they collect and use in their research in the ELN.
- Reported shortcomings of LabArchives include editing within the rich text editor, compatibility with certain data types and formats, and missing features such as robust drawing tools.
- Non-users included those who had requested an account but never used the ELN or had used it but stopped. Chief reasons for discontinuing use were dissatisfaction with the user interface, preference for another tool, or incompatibility with data types or software (e.g. chemical structure software, computer code). Barriers such as incompatibility with wet bench research and lack of time to learn a new system were also deterrents, particularly for those who had set up accounts but never actively used the system.
- There was agreement among all respondents, both users and non-users, that campus should continue to provide an ELN service. Current users of the system favored continuing with LabArchives while non-users were generally neutral or opposed. Most respondents were open to having the University look into alternatives.

Based on this data, the ELN Service Team recommends that:

- The University should continue providing an ELN service to researchers; users find it very useful for maintaining a complete and long-term record of their research. In addition, a campus level ELN service includes processes and safeguards that ensure the system is stable and secure, allowing faculty and students to focus on research rather than assessing these capabilities of ELN systems themselves.
- The University may want to look into additional notebook systems that better integrate with ChemDraw and computer code for researchers who need these features.
- The ELN service team should put more focus on training and awareness of important functions like regular exporting, Folder Monitor, and Microsoft Office plug-in in its current onboarding and outreach activities.

Background and Objectives

In November 2018, four years after the launch of UW-Madison's ELN service, the University's ELN Service Team conducted a survey to gauge the value of the system to researchers and help the ELN Service Team improve their practices for supporting researchers and labs with data storage and management.

Methodology

The survey was sent out via email to approximately 1,500 individuals with researcher accounts on the University's LabArchives system (whether actively using the platform or not). We received 155 responses, which is approximately a 10% response rate. Of these responses, 8 were incomplete and discarded. The remaining 147 complete responses were analyzed in this report.

The survey contained 25 questions and the full survey instrument is contained in the Appendix at the end of this report.

R and NVivo were used to code and analyze the survey data. Given the relatively small sample size of the survey responses, this report adopts Fisher's exact test and chi-square test with simulated p values when analyzing cross tabulations.

Results

Demographics and Requirements for Research Records

Of the respondents, 49 were in Biomedical disciplines, 47 were in Agriculture and Life Sciences, 30 were in Physical Sciences, 9 were from Engineering, 2 were from Social Sciences, and the remaining 8 identified their research discipline as "Other" (Figure 1). Principal Investigators (PIs) or faculty members comprised 22% of respondents, and the remaining 78% were non-PIs, a category that includes graduate students, undergraduate students, postdoctoral trainees, staff scientists, or other (Figure 2).

Figure 1. Which of the following best describes your main research disciplinary area?

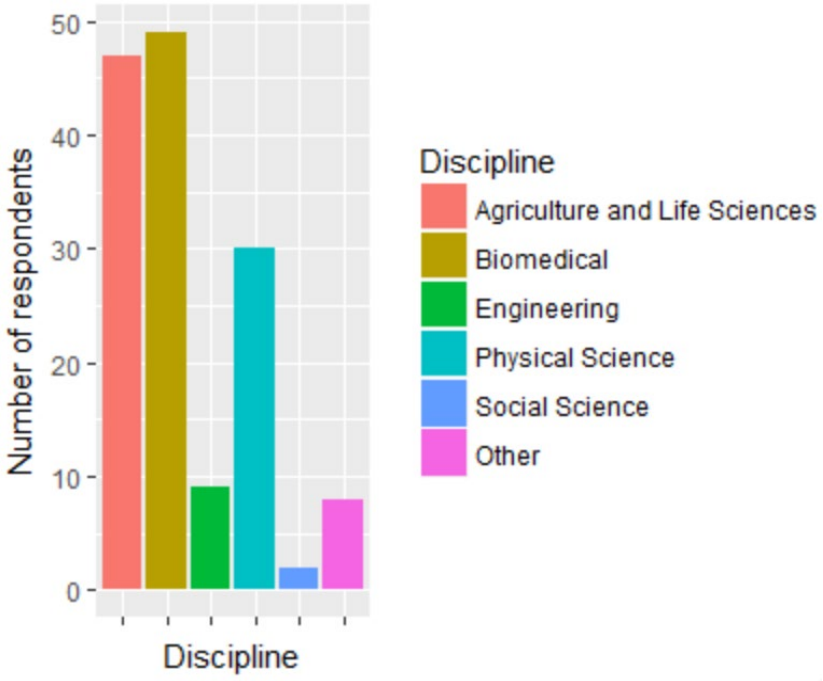
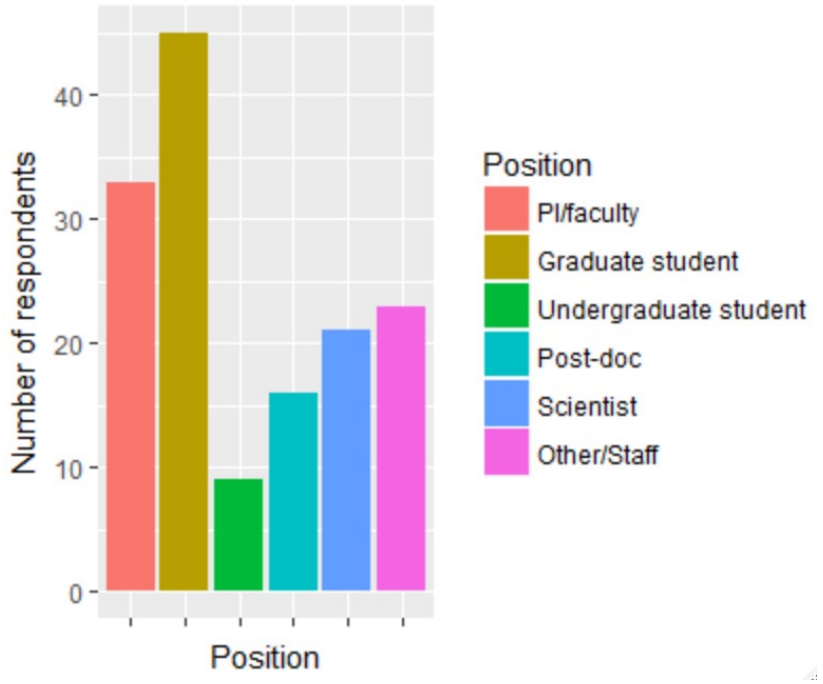


Figure 2. What is your current position at the UW-Madison?



Each respondent was asked whether the PI of their lab had requirements for how lab members documented their research. Figures 3 and 4 show responses from the PIs themselves (Figure 3) and from non-PIs (Figure 4). Among the PI respondents, 58% indicated that they had specific

requirements for research documentation, 36% said they had general requirements, and 6% of PIs indicated they had no requirements. For the non-PI respondents, 62% thought their PIs had general requirements, 26% indicated their PIs had specific requirements, 9% thought their PIs did not have any requirements, and 3% were not sure about their PIs' requirements. This shows that most research groups in this sample have some requirements regarding documentation and recording of research.

Figure 3. Which statement best describes the type of documentation/records you require members of your research group to keep of their research?

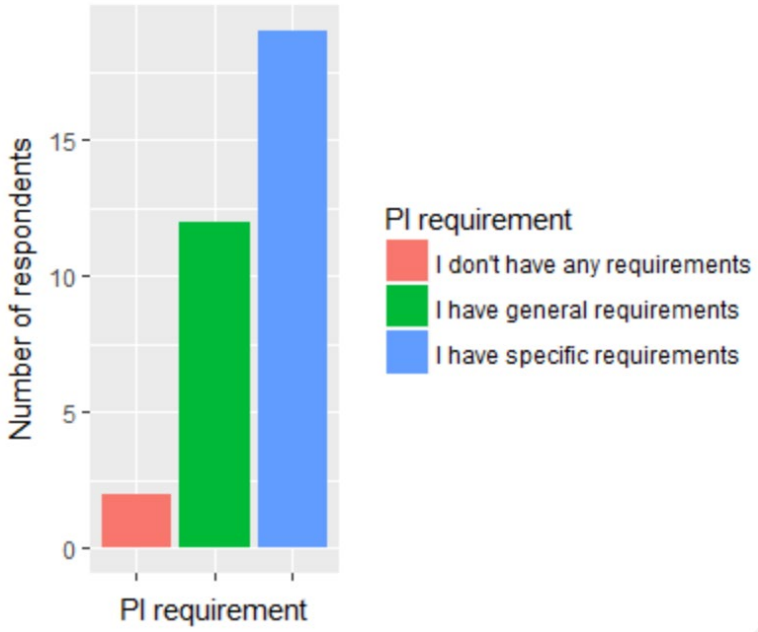
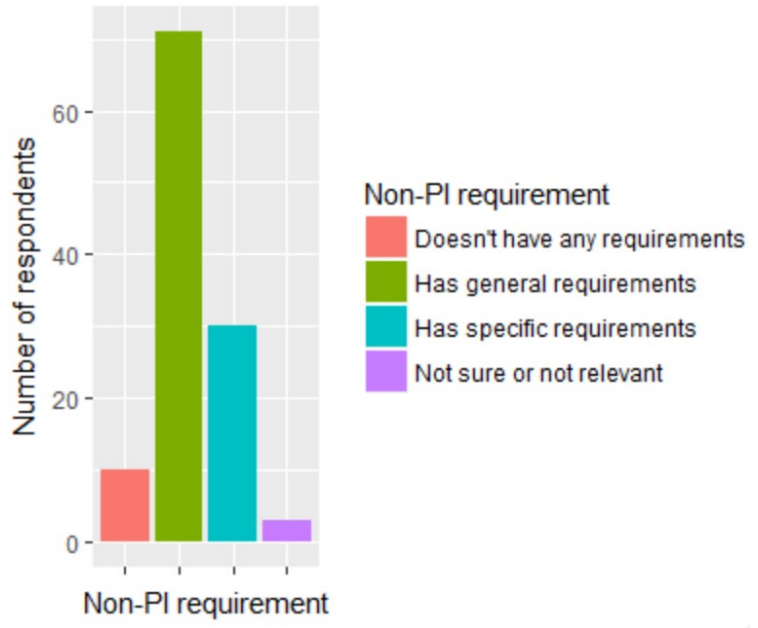


Figure 4. Which statement best describes the type of documentation or records your PI/research advisor requires you to keep for your research? My PI . . .



Usage of LabArchives

Current LabArchives users comprised 94 (63.9%) of respondents at the time of the survey. Among the 53 (36.1%) non-users, 28 (19%) had used LabArchives in the past but decided to stop using it, 20 (13.6%) had only logged in a few times, and 5 (3.4%) had never logged in (Figure 5). However, 4 of the PIs who self-identified as non-users (likely because they had never logged in or used the system themselves) were moved into the user category for the survey analysis because they indicated that others in their lab group were users.

Figure 5. Which of the following best describes your use of the LabArchives Electronic Lab Notebook system?

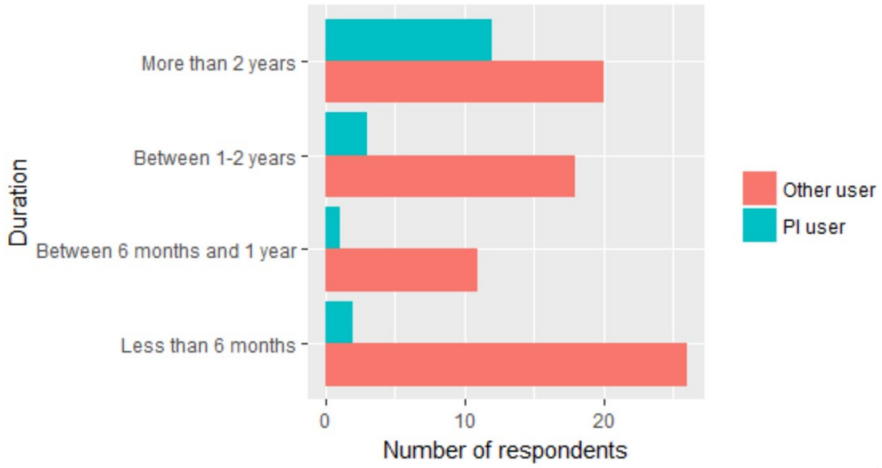
Table 1 presents a cross tabulation showing the relationship between respondents' usage of the ELN and its use by others in their lab group. It indicates that most users were in groups or labs where others were also using LabArchives, while non-users were more likely to be in groups or labs where no one or only a few individuals used LabArchives. This suggests that among these survey respondents, adoption of LabArchives may be more successful if the whole group or lab uses it rather than just a subset of the lab.

Table 1. Do others in your research group/lab use LabArchives?

	Other non-user	*Other user*	*PI non-user*	*PI user*
No	17	6	11	1
Yes, a few others use it.	11	12	0	5
Yes, about 50% of the group uses it.	2	8	0	3
Yes, nearly everyone in the group uses it.	4	48	0	12
I'm not sure.	4	2	0	1

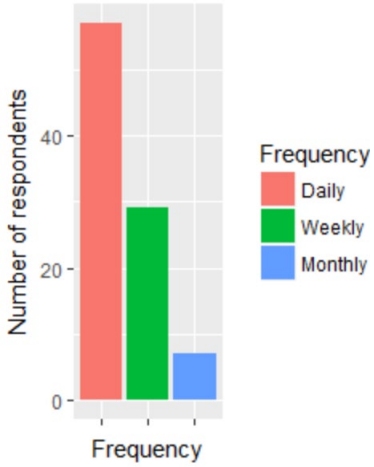
Users were asked how long they had been using the LabArchives service. Figure 6 shows the responses of PIs versus users in other positions. While non-PI users were generally variable in the duration of their use of the service, the majority (66.7%) of PI users indicated they have been using it for two or more years (i.e., p = 0.02, when compared with PI users using LabArchives for less than 6 months). This difference between PIs and other users likely reflects the stability of the PI compared to other roles that turn over as new members join the lab and graduate. It may also suggest that PIs who are long-term LabArchives users were highly motivated to complete the survey, compared to PIs who have been using the service for shorter durations.

Figure 6. How long have you been using LabArchives?



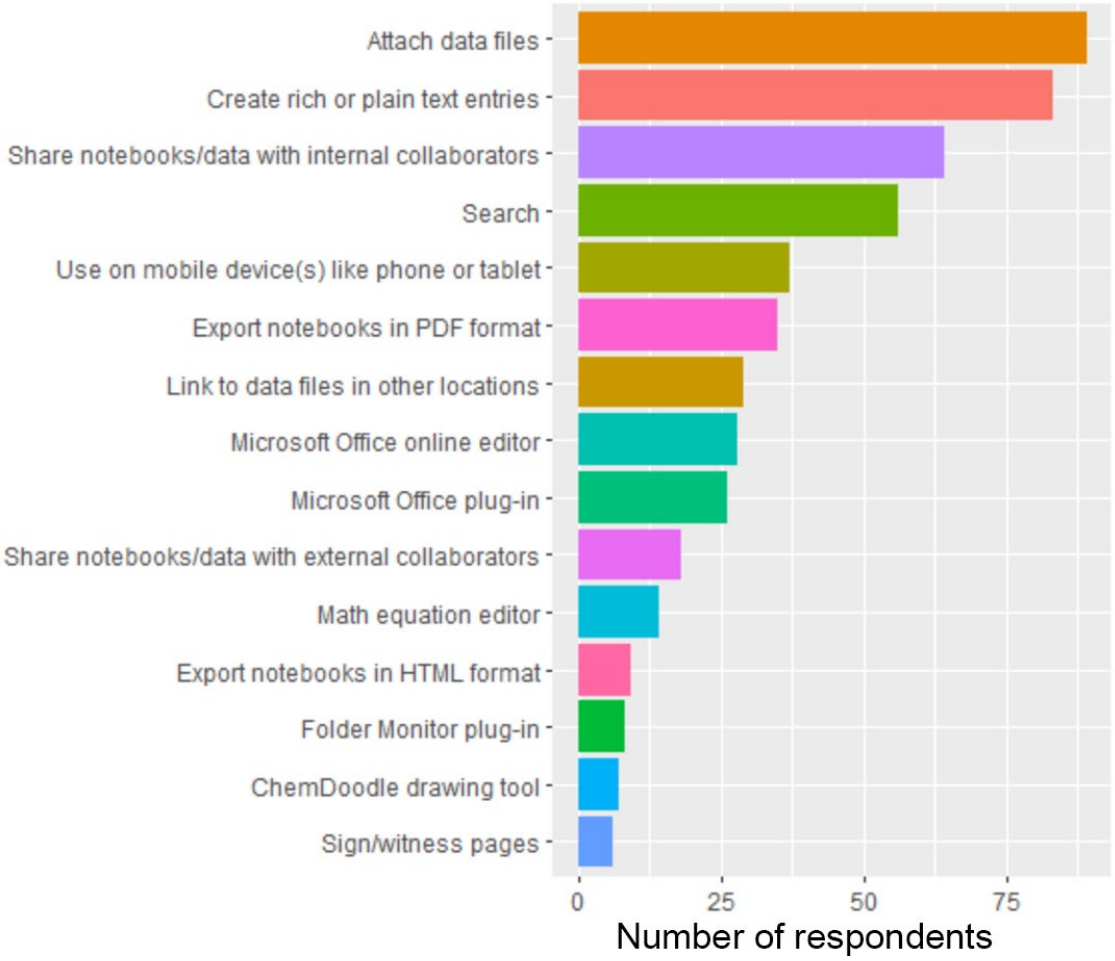
When asked about the frequency of ELN use (Figure 7), 61% of users reported using LabArchives daily, 31% reported using LabArchives weekly, 8% reported using LabArchives on a monthly basis, and no one reported using it only a few times a year. This shows that most users are accessing the system to record and update their research on a fairly regular basis.

Figure 7. How frequently do you use LabArchives?



Users were asked to indicate all the features of LabArchives they used (Figure 8). Of the 15 features presented, attaching data files was the most frequently selected (89 users), followed by creating rich or plain text entries (83 users), sharing notebooks or data with members of the research group (64 users), and searching (56 users). The least used feature was signing or witnessing pages (6 users). Other less-used features included the ChemDoodle drawing tool (7 users), Folder Monitor plug-in (8 users), exporting notebooks in HTML format (9 users), the math equation editor (14 users), and sharing notebooks or data with collaborators outside their research group (18 users).

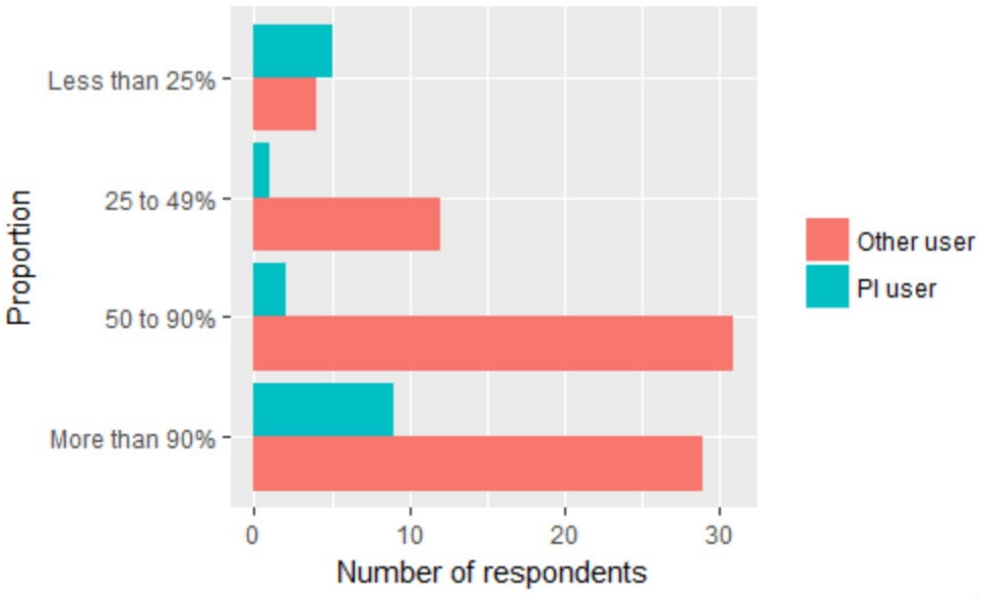
Figure 8. Which features of LabArchives do you use? (Select all that apply)



Users were asked what proportion of their research data they uploaded/attached into LabArchives (Figure 9). PI and non-PI users were again considered separately, because non-PIs collect and use data for their own projects only, while the purview of the PI is generally over the entire lab's data. Most non-PI users and PI users uploaded half or more of their data in LabArchives. However, a significantly higher proportion of users storing less than 25% of their research data in LabArchives were PIs ($p = 0.02$).

LabArchives provides unlimited data storage and allows uploads of individual files less than or equal to 4 GB. Based on the responses shown in Figure 9, these capabilities appear to allow many users to keep a substantial portion of their research data in the ELN. However, a number of labs that have adopted the ELN likely generate data that is not readily uploaded to the ELN such as large image files, data outputs from multiprocessor computing, and/or numerous files from instruments. This supposition is supported by open-ended comments from some respondents regarding a need for massive data storage (Table 9).

Figure 9. What proportion of all the data that you create and use in your research do you upload (attach) into LabArchives?



78% of users indicated they used LabArchives as their primary tool for recording their research, while only 17% indicated they did not (Figure 10). The latter set of individuals responded that in addition to the ELN, they also used paper notebooks (5 users), Microsoft Office software like OneNote, Excel, Word, or PowerPoint (3 users), personal computers (3 users), and other options including Box, Google Drive, KaleidaGraph, and shared servers.
Figure 11 shows the results of a question asked only of non-users who had indicated that they had never used LabArchives. Their responses indicate that most of them had considered using LabArchives at one time.

Figure 10. Is LabArchives the primary tool you use for recording your research?

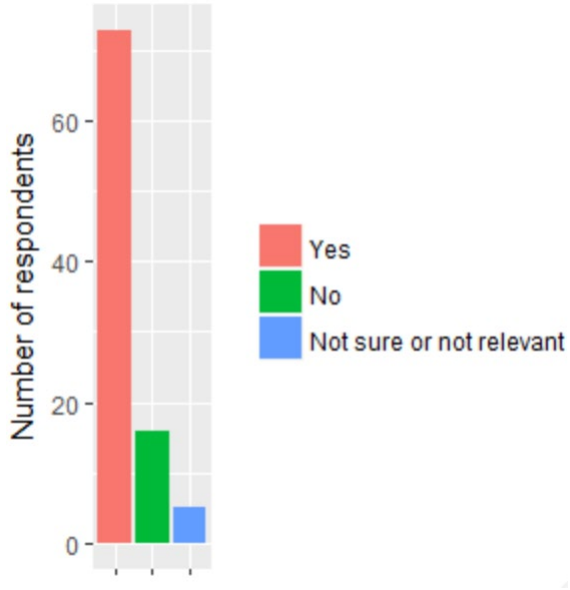
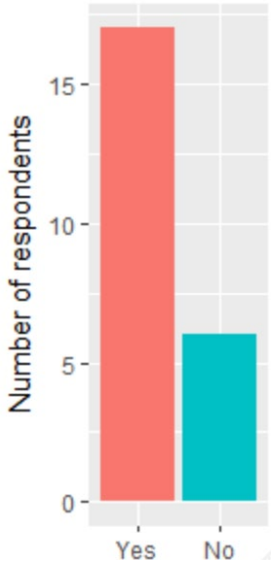


Figure 11. Have you considered using LabArchives? (Non-users only)



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Opinions of LabArchives and Other Tools

Users

Benefits of LabArchives

Users were asked an open-ended question about the main benefits of using LabArchives (Table 2). The most frequent response related to the benefits of using a cloud-based electronic platform that provided access for everyone in their groups and which could be accessed anywhere using multiple devices. 11 PI users and 27 non-PI users mentioned this in their responses; one PI also mentioned that it helped "cut down on paper waste."

The second most frequently cited benefit related to users' ability to keep a complete, permanent record of their research using the ELN. This was mentioned by 10 PI users and 17 non-PI users. Some PIs noted that their groups' notebooks in LabArchives were "a complete record of experiments," "a long-term archive of research," and served as "a solid record" with

"no lost documents." In their responses, they appeared to focus on the long-term, big picture for their whole lab/group when talking about this benefit. Examples of information users listed as being included in their LabArchives notebooks included "lab notebook data, protocols, pipelines, accurate logs of experiments, procedures, freezer maps, templates," and other information related to experiments. Users also indicated that version control and time stamps were useful in keeping a full record of their work. Others (mostly non-PIs) described the magnitude and types of data they could store in LabArchives as a benefit of recording their research in LabArchives.

Other frequently described benefits of LabArchives were its searchability and flexibility for information organization. Several users described in detail what they liked about LabArchives' organizational options, such as its "ease of linking data," "consistency in progress," "consolidated information," "ability to copy notebook pages for re-running similar reactions," and "organization of pages into folders based on projects on one platform."

LabArchives' compatibility with data types, support for collaboration, and ease of use were three additional benefits some users mentioned in their responses. Compatibility related to users' ability to integrate different types of data and documents within the ELN. PI users noted they could "insert graphics, append files," add in "supporting documents of all kinds," and "have Excel worksheets integrated into notebooks pages." Non-PI users also mentioned "raw data," "hyperlinks to link to relevant papers," "different media types," "Microsoft applications," and "PDFs" when describing compatibility with data types. Two also mentioned LabArchives' export functions with downloadable links. Support for collaboration was mentioned as a benefit by a number of users. PIs found LabArchives "easy for lab members to collaborate" (in particular for mentor-mentee relationships) and enabled members to "share data between each other so that questions that might arise about an experiment or approach can be investigated immediately by looking at the notebook." Non-PI users indicated similar benefits and also mentioned the value of being able to share updates, read others' notes, and be selective about what to share and who to share with since "sharing intellectual property with only those who need to see it in early stages" can be a concern. Ease of use was mentioned solely by non-PI users and for many of them in the context of an improvement over paper notebooks, noting that the ELN made it "easy and quick to take notes," allowed them to record notes in lab with "a covered tablet," "copy a previous page," and removed the need to interpret their own or others' handwriting.

A few users mentioned other benefits like not losing any data, the ability for PIs to manage members' work, the ability to multitask between "multiple diverse projects" or track experiments while also doing "administrative tasks" like "chemical analysis instrumentation maintenance and repairs." One user noted that they received good user support from LabArchives, and another found "figures and widget features" to be useful.

Table 2. What have you found to be the main benefits of using LabArchives? (N = 80)

Benefits	Number of References
Cloud-Based (Online)	6 (Total: 38)
• Access Anywhere	• 23
• Access for Everyone	• 8
• Environmental Friendliness	• 1
Complete Permanent Record	27
Searchability	24
Good Organization	23
Compatibility with Data Types and Formats	21
Support for Collaboration	15
Ease of Use	12
Security of Data	5
Manage Lab Member's Work	4
Serving Multiple Purposes	3
Good User Support	1
Useful Functions	1

Limitations and Disadvantages of LabArchives

Users were also asked to list limitations or disadvantages they found using LabArchives (Table 3). Issues with the editing functions in several of LabArchives' entry types were mentioned most often (25 users). Several comments referenced limitations of the rich text entry and included problems with resizing pictures embedded in that entry type. Respondents stated that they could not figure out how to resize images with rich-text entries, and they were disappointed there was "no auto resizing of images." Other comments indicated limited functionality of tables and text formatting when editing within a rich text entry. Other users described limitations of editing with two additional LabArchives' entry types; the sketch entry (limited functionality) and the chemical sketcher entry (no support for labeling or annotating chemical structures). LabArchives offers several options for editing Microsoft Office documents, including integration with Microsoft Office Online for editing a document stored in an attachment entry and a Microsoft Office plugin application that allows documents stored in LabArchives to be opened, edited, and saved directly in the native Microsoft Office applications installed on the user's laptop/desktop. Despite these options, a few users reported difficulties related to editing Microsoft Office files saved in LabArchives, finding one or more of the options were "not straightforward" or required workarounds for simultaneous editing of the same document.

Compatibility, broadly defined as the ability to attach and display data files in LabArchives, was the second most frequently mentioned type of limitation (20 users). Compatibility was also recognized as a benefit of using LabArchives by the same number of users in the preceding section; however, users who described compatibility as a limitation tended to emphasize

difficulties uploading and rendering certain data file formats such as TIFF images in rich text entries, MathJax output files, emails, Google slides, or ChemDraw file formats.

The third most frequently described type of limitation (16 users) related to specific features lacking either in functionality or entirely missing in LabArchives. Those missing included the ability to sort “page entries by date,” “display codes with syntax highlighting,” the ability to lock “people out of a file” to prevent overwrites, a “page view,” and support for hand-drawing. Examples of existing functions that could be improved included flipping “between pages,” saving files with “the desktop plug-in,” “the Latex editor,” and “MS Word and Excel extensions.”

Some users noted that LabArchives was not as good as other tools they used to record their research, including paper notebooks, Microsoft Word, OneNote, Excel, PowerPoint, or ChemDraw. A few thought the interface of LabArchives was somewhat “clunky” and not intuitive. Comments describing these limitations included “only layout being a long list for an entry with slow rearranging”, “you have to check a box for a page name to be saved”, and “I cannot get tables to behave the way I'd like.” Other users noted limitations of the mobile application for viewing contents and making edits while others indicated they would have liked to be able to access multiple entries, pages, or notebooks simultaneously.

A few users mentioned that it was difficult for them to use LabArchives in the lab “during experiments” or “on a wet bench” as it required typing with a keyboard and was “not always actively on.” Finally, a small number of users reported issues organizing files, problems searching for unclearly or incorrectly marked data, disappointment with features such as widgets, difficulties sharing notebooks with others, frustration about the time needed to learn and adopt the ELN, or uncertainties about how long the University would support the service.

Table 3. What have you found to be the main limitations or disadvantages of using LabArchives? (N = 78)

Limitations or Disadvantages	Number of References
Issues With Editing	25
Compatibility Issues with Certain Data Types and Formats	20
Limited or Missing Features	16
Other Tool Preferred	10
Interface Issues	13
Not Suitable for Research Scenario	9
Issues With Mobile Application	7
Issues With Organization	3
Issues With Searching	3
Functions Not Useful	2
Issues With Sharing	2
Learning Curve	2
Unsure About Ongoing Support	1

Non-users

Reasons for Not Using LabArchives

The group of respondents who indicated they used LabArchives in the past but were not currently using it were asked why they stopped (Figure 4). Among this group of respondents, the most frequent reason was LabArchives' interface, which some described as clunky and/or non-intuitive (9 respondents). Non-PI respondents who gave this reason generally referenced their own experience, while PIs providing this reason also mentioned their lab members' experience in their decision to discontinue using LabArchives.

The second most common reason for discontinuing use of LabArchives was preference for another tool, such as OneNote, paper notebooks, Box, Google Drive, or Findings. Less frequent reasons included compatibility issues with other software such as ChemDraw or the extra time needed to document their research in LabArchives ("I have a tough time dedicating time to log in and add my data and files."). A few (non-PI) respondents indicated they stopped using LabArchives because they stopped working in the lab in which it was used or because they lacked access to computers or tablets in their lab. Two respondents noted that their labs decided to not use LabArchives but did not provide specific reasons. Other Issues ranging from problems with sharing notebooks to the functionality of mobile applications were described by 1 respondent each.

Table 4. What are some of the reasons you stopped using LabArchives? (N = 28)

Reasons for Stopping Using LabArchives	Number of References
Interface Issues	8
Other Tool Preferred	6
Compatibility Issues with Certain Data Types and Formats	5
Time Consuming or Extra Work	5
Changed or Discontinued Research or Lab	4
Not Suitable for Research Scenario	2
Lab Discontinued Use	2
Other	2
Difficulty Managing Notebooks	1
Dubious Sustainability	1
Issues with Mobile App	1

A second group of non-users had accounts on the LabArchives system but had never logged in or had logged in only a few times and never actively used it, even though most had considered using it at one time (Figure 11). This group was asked the reasons for not using the service. The most frequent reason given (Table 5) was their sense that LabArchives was not as good as other tools they used, including Arxspan, paper notebooks, Box, OneNote, and/or shared Google Docs. Several respondents indicated they thought adopting LabArchives would be time consuming, creating “one more step” that required “effort” and planning or that it would be “cumbersome” to “set up,” “use,” and “share.” Others thought it would be difficult to link to images, databases and spreadsheets, or integrate with software code, chemical structure files, and/or large files using LabArchives. A number of respondents indicated that a digital lab notebook was not a good fit with their lab’s or their own research scenario because computers were not available or could not be used at the bench, or they needed to capture detailed hand drawings, and/or they needed to record their research when network connectivity was not available. A few respondents indicated they were not sure about the “value and versatility” of LabArchives or had encountered resistance to its adoption from lab colleagues. Two respondents indicated they had not gotten a response to their request for a consultation and one respondent indicated that they had not used LabArchives because their work had not involved extensive lab work.

Table 5. What are some of the reasons you have not used LabArchives? (N = 20)

Reasons for Not Using LabArchives	Number of References
Other Tool Preferred	6
Time Consuming Or Extra Work	6
Not Suitable for Research Scenario	4
Compatibility Issues with Certain Data Types and Formats	3
Concerns About Value/Versatility	3
No Reply For Consultation Request	2
Not Doing Lab Work	1
Low Buy-in by Lab	1
Interface Issues	1

Factors for Potential Adoption of LabArchives

Individuals who indicated they had previously used LabArchives but had stopped were asked whether there were any factors that would make them consider using LabArchives again (Table 6). Several said that there were no factors that would make them consider using LabArchives again. In some cases, this appeared to be because they were using other systems better suited to their research, such as Jira and Jupyter notebooks. A few said they would consider LabArchives if it provided better compatibility with devices or other systems such as iPad Pro, Jupyter, ChemDraw, UW servers, or lab software generated data. Others indicated that they would consider using LabArchives again if it were redesigned to be "more streamlined and sleek" with "substantial UI improvements," or if it were "completely re-designed," or "more like Google drive." Other reasons included having "more time to keep a well-organized lab notebook" or more information on how to use the system. A couple of respondents indicated they might consider using it again if they needed it for their research focus or if they had a device that enabled them to use it at the bench. One respondent indicated that they would only use LabArchives again if they had a "firm guarantee" of its long-term sustainability for at least 10 years.

Table 6. Are there any factors that might make you consider using LabArchives again? (N = 24)

Factors for Reconsidering LabArchives	Number of References
None or Likely None	8
Improvement In Interface or Redesign	6
Improvement In Compatibility	5
More Time or Information	2
Fit With Research Scenario	2
Guarantee Of Sustainability	1

The other set of non-users, respondents who had either never logged in to LabArchives or had only logged in once or twice, were also asked what factors would make them consider using LabArchives in the future. Several indicated they probably would not consider using LabArchives, but others indicated that they might consider using it if it was appropriate for their lab scenario. This included one respondent who indicated their entire lab was currently adopting it, a PI whose lab was conducting a trial using LabArchives on tablets to enable use at the bench, and another PI who would consider it if his/her group were willing. A couple of respondents indicated that improved compatibility with tools that they used (stylus, chemical structure software) would make them consider using LabArchives. Others indicated they would potentially be interested in using it in the future if it offered better ways to share information with internal or external collaborators or if they had more time or information to use it effectively. Finally, one respondent indicated they would consider using it if there were a way to deposit their results when leaving the University.

Table 7. Are there any factors that might make you consider using LabArchives in the future? (N = 14)

Factors for Considering LabArchives	Number of References
Fit With Research Scenario	4
None or Likely None	3
Improvement In Sharing	3
Improvement In Compatibility	2
More Time or Information	1
Ability to Archive	1

Alternative Research Recording Tools

Non-users of LabArchives were asked to list tools they used for recording their research (Table 8). While there was some degree of convergence around paper notebooks, Microsoft Office, personal computers, hard drives, Box, and Google, the list of tools was broad with many tools listed by each respondent.

Table 8. Please list some of the tools you use to record your research. (N = 48)

Tools for Research Recording	Number of References
Paper	33
Microsoft Office	18
Hard Drives Or PCs	7
Box	6
Unidentified Software	5
Google	4
Shared Server	3
GitHub	2
Jupyter	2
MATLAB	2
AfterMath	1
Arxspan	1
Asana	1
Basecamp	1
Benchling	1
ChemDraw	1
Coins	1
Data Vault	1
Dropbox	1
Electronic Image	1
External Databases	1
File Archives	1
Findings	1
Git	1
iPad Notebook	1
Jira	1
Mathematica	1
Mediawiki	1
Mestrenova	1
Mosaics Vivarium	1
None	1
Overleaf	1
Own Shared Database System	1
Python	1
R	1
Readme	1
Redcap	1
Slack	1

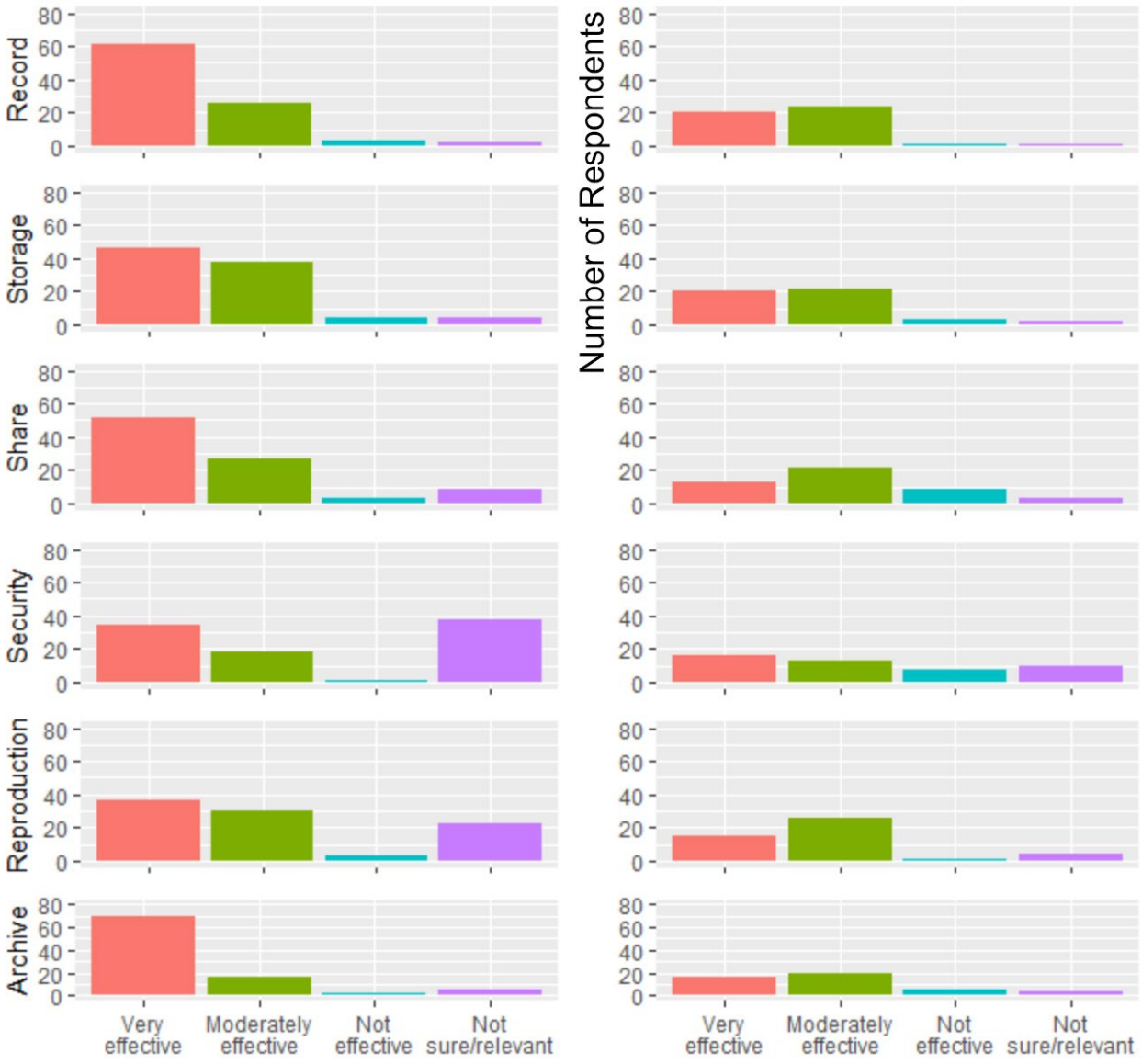
Comparison of LabArchives and Other ELN Services

All respondents were asked how effective they found the tools they used to record their research in regard to six areas: keeping a complete record of research, storing and organizing data, sharing findings with others, protecting confidentiality and/or intellectual property, making research reproducible, and creating a long-term archive of research. Users of LabArchives were asked to consider LabArchives in their responses, and non-users were asked to consider the tools they listed in the previous question. The results can be seen in Figure 12.

Most LabArchives users found it moderately to very effective in all six of these aspects. A majority of users rated it as very effective for keeping a complete record of research (61 users out of 92, or 66.3%) and creating a long-term archive of research (70 users out of 93, or 75.3%). A smaller proportion rated it as very effective for storing and organizing data (46 users out of 92, or 50%) and sharing findings with others (52 users out of 90, or 57.8%). Users were less certain about LabArchives' effectiveness for protecting confidentiality and/or intellectual property, with a substantial number (41.8%) indicating they were "Not sure or not relevant" and 24.2% users indicated the uncertainty about the effectiveness of LabArchives for making research reproducible.

Most non-users also rated the tools they use to record their research (Table 8) as moderately to very effective in all six areas. Compared to users' rating of LabArchives, non-users were less likely to rate their research-recording tools as very effective for keeping a complete record of research (44% vs 63% for LabArchives users) or creating a long-term archive of research (34% vs 75% for LabArchives users).

Figure 12. How effective is LabArchives (Left) or other tools (Right) for each of the following?



Opinions about Continued Support for ELN

All respondents were asked about their level of agreement with ongoing support for a campus ELN service. When asked whether UW should continue to provide a campus ELN (Figure 13), no respondent disagreed. The majority of PI users (18 out of 22, or 81.8%) and non-PI users (63 out of 75, or 84%) strongly agreed that UW should continue providing a campus ELN. The majority of PI non-users (6 out of 11, or 54.5%) and other non-users (23 out of 34, or 67.6%) also agreed with this statement. A substantial number of non-users were indifferent about the continuation of the campus ELN service.

Figure 13. What is your level of agreement with the following statement? It's important that UW continue to provide a campus ELN.

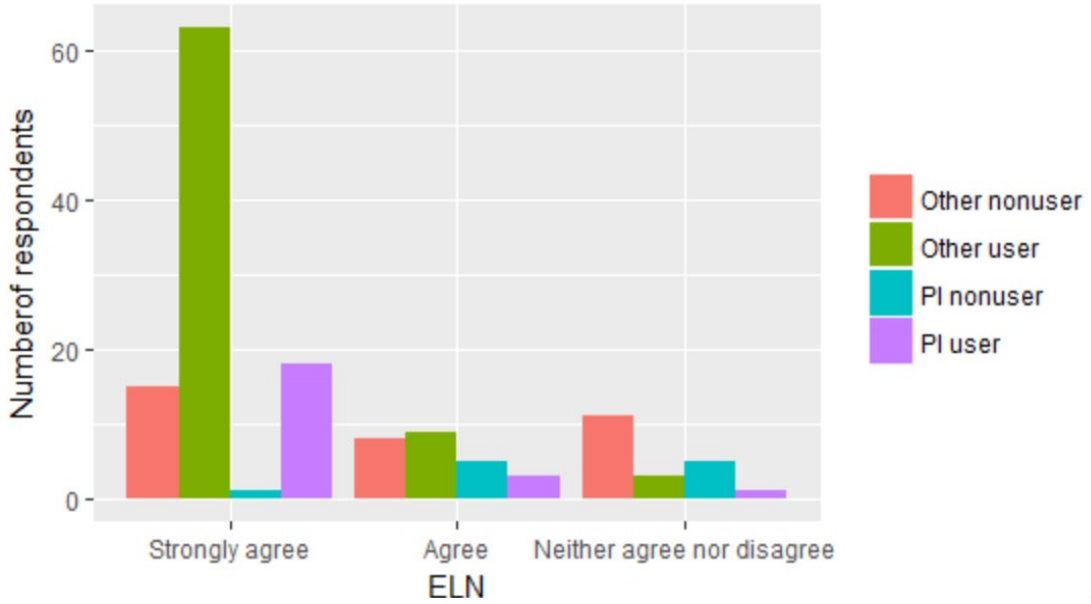
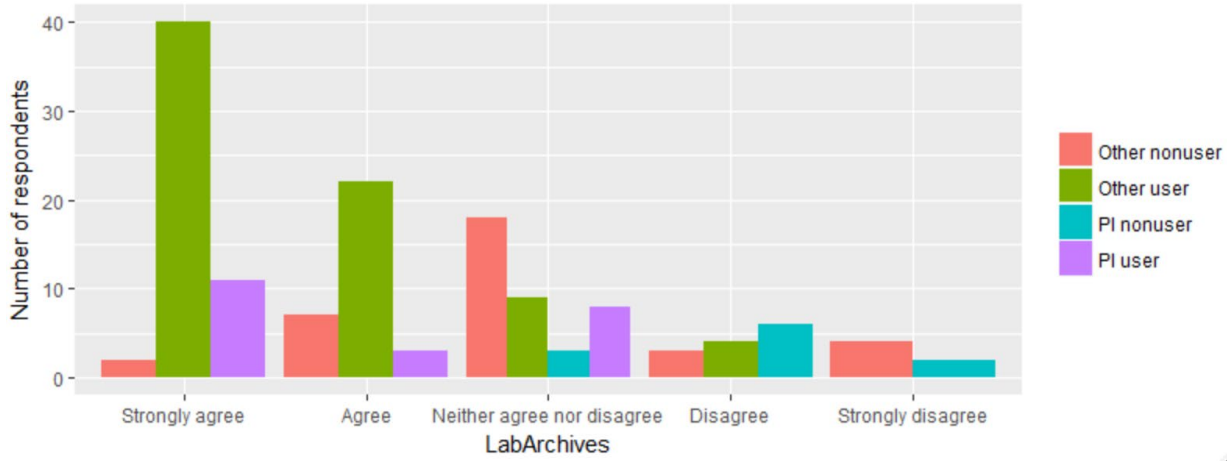


Figure 14. What is your level of agreement with the following statement? It's important that UW continue to use LabArchives as the campus ELN.



When asked their opinion about whether UW should continue to use LabArchives as the campus ELN (Figure 14), no PI users disagreed. Half of the PI users (11 out of 22) strongly agreed that the University should keep LabArchives as the campus ELN, while 36.4% of the PI users were indifferent. The majority of non-PI users (40 out of 75, or 53.3%) also strongly agreed with the University's continued use of LabArchives, together with 22 more (29.3%) who chose "Agree." There were 9 (12%) non-PI users who did not have an opinion, and 4 (5.3%) disagreed with the continuation of LabArchives as the campus ELN. None of the PI non-users agreed that the UW should continue with LabArchives, and most of them (8 out of 11, or 72.7%)

either disagreed or strongly disagreed that the University should keep choosing LabArchives as the campus ELN. However, the majority of non-users who were not PIs (18 out of 34, or 52.9%) were neutral on the subject of continuing with LabArchives.

When all respondents (both users and non-users) were asked about their level of agreement regarding UW looking into alternatives to LabArchives for the campus ELN (Figure 15), the most frequently selected response was “Neither agree nor disagree” (57 out of 141, or 40.4%). Twenty-nine (20.6%) respondents disagreed, but the remaining 55 (39%) agreed that the University should conduct a search for alternatives to LabArchives.

Figure 15. What is your level of agreement with the following statement? It's important that UW look into alternatives to LabArchives for the campus ELN.

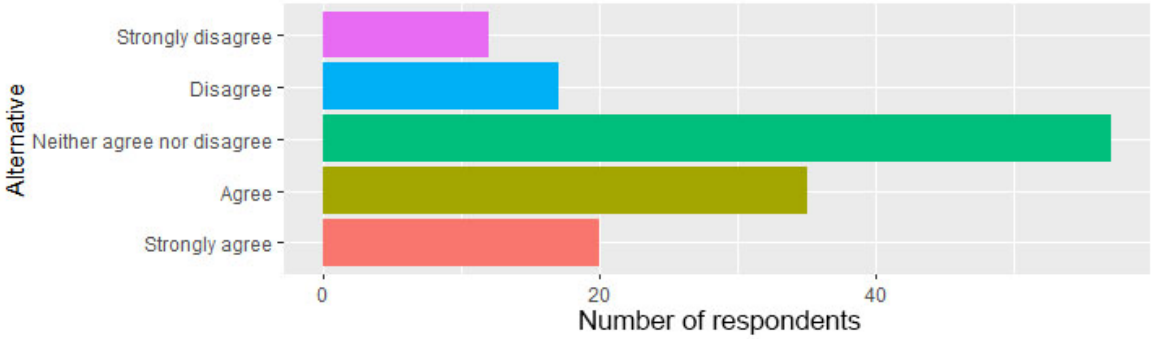
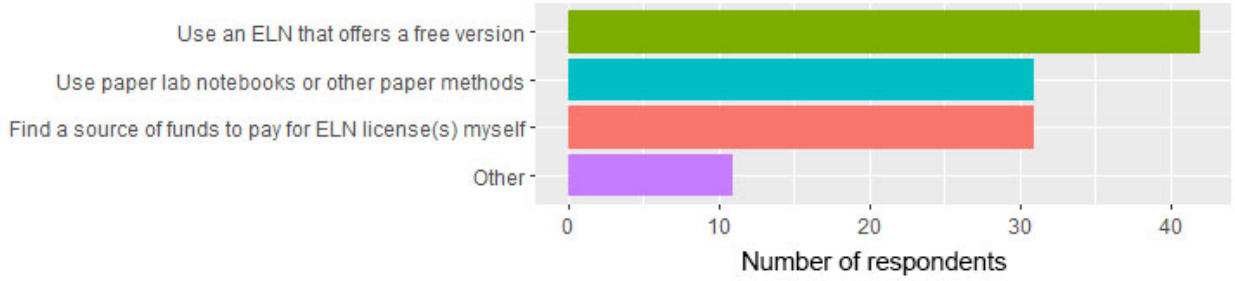


Figure 16. Hypothetically, if UW-Madison discontinued support for the campus ELN, which of the following options would you pursue? (Select all that apply)



When users were asked about what they would do if UW-Madison discontinued support for the campus ELN system (Figure 16), the most selected option was to use an ELN that offers a free version (42 users). The options to use paper lab notebooks or other paper methods and to find a source of funds to pay for ELN license(s) themselves were both selected by 31 users, and some users also mentioned other options including Microsoft OneNote, Box, and personal computers, etc.

Additional Tools and Comments

Toward the end of the survey, the respondents were asked to list other tools or services they thought UW-Madison should provide for research data, and any other additional comments. A list of tools and services named can be found in Table 9. Storage of massive data was mentioned by 6 respondents, and a few respondents asked for alternative ELN services like Benchling, EndNote, and PerkinElmer Signals.

Table 9. What other tools or services should UW-Madison provide for research data? (N = 56)

Tools and Services for Research Data	Number of References
None	15
Storage Of Massive Data	6
Alternative Organization Or Lab Notebooks	2
Benchling	2
EndNote	2
Illustrator	2
PerkinElmer Signals	2
UW Owned Data Storage Space	2
Add-On To Configure For 21cfr Part 11 Compliance	1
Arxspan	1
Automatic Data Archiving	1
Automatic Uploading To NIH Database Repositories	1
Bench-Top Data Entry Devices	1
Box	1
Box Back-Up	1
CambridgeSoft	1
CDD Vault	1
Data Back-Up	1
Data Migration Tool	1
Data Storage For Ease Of Future Use	1
ELN Extended Beyond UW-Madison	1
ELN Supporting ChemDraw	1
Exporting Usable Form Of LabArchives Notebooks	1
Findings	1
Google	1
iLabs	1
Improving LabArchives Or Other ELNs	1
iPad Pro Compatible ELN	1
Jupyter	1
Lockbox LIMS	1
Long-term Data Storage	1
MATLAB	1

Microsoft Office	1
MiliporeSigma	1
Need Help Setting Up Accounts	1
Notepad For Tablets	1
Online Accessible Servers	1
PerkinElmer WebElements	1
Project Based Planning	1
Research Protocol Database	1
SciNote	1
Shared Data Storage	1
Unidentified	1

When writing additional comments, 5 PIs and 12 non-PI respondents were quite positive and satisfied about their overall experience with LabArchives and expressed their wish that the university would continue to provide the service. A few examples are as follows:

> *LabArchives has been improving a lot for our needs. I use it a lot for data storage, which allows for great version control and shared access. Otherwise you would end up on platforms like google drive (unsafe) or scattered on box (no option to load in research notes and lab experiment info). I am a big fan of the ELN, it makes group work and mentoring so much more convenient. The ease to work with our undergraduates on projects and to see their progress realtime is fantastic, you provide instant feedback, pull it up whenever. Files can be moved from machine to notebook electronically instead of being handwritten (with errors).* – A non-PI respondent
>
> *I think this is a HUGE advance. Our lab has been slow to adapt, but new members are jumping on board and I am close to mandating its use -- it is tremendously beneficial!!* – A PI respondent
>
> *It changed the way that I do science!!!* – A non-PI respondent
>
> *Please do not discontinue this excellent service.* – A non-PI respondent
>
> *I think if UW discontinues supporting ELNs, this will dampen any enthusiasm for the adoption of electronic archives and this will have consequences in the long run.* – A PI respondent

On the other hand, 3 PIs and 5 non-PIs were negative about LabArchives and general ELN services, as they found it time-consuming or difficult to use compared to paper notebooks and other tools or had concerns about the sustainability of the service. 1 PI and 6 non-PIs offered constructive feedback about what they would like to see in an ELN service, such as working

“better and faster” “with a broader range of tools and functions”, “a calendar of experiments link to notes”, “keep looking at what is out there”, “support and lots of advance warning about the discontinuation”, and exporting data “to the new system.”

Conclusions

Overall, the results of this survey suggest an ongoing need for a campus ELN service for researchers at UW-Madison. The majority of respondents, both users and nonusers, were in agreement that the University should continue to provide the ELN service. While the university provides other enterprise tools that can be used for storing research data, such as Box and Google Drive, ELNs provide interfaces for integrating various elements of the research process, such as methods, data, analysis, and interpretation of the data, thereby allowing users to document the entire research process. This unique ELN feature may in part explain why LabArchives users in this survey rated it as more effective for keeping a complete record and long-term archive of research than non-users rated the set of tools they used.
Results of this survey indicate that methods for recording and documenting research are important to researchers; the majority of PI respondents indicated they had specific requirements for their groups/labs and most non-PI respondents reported that their PI had general to specific requirements. When users were asked about what they would do should the campus ELN service be discontinued, the majority responded that they would either look for a free ELN service or find funding to purchase ELN licenses, providing additional evidence that users see an ELN as an important tool for research.

Most users of the current ELN system, LabArchives, noted benefits of using it and a majority were in favor of continuing with it as the campus ELN. Top advantages described by users included easy access for all members of a lab group, searchability, compatibility with a number of different data types, and ease of use. Shortcomings of LabArchives were also identified by users. Chief among these were dissatisfaction with specific editing functions such as the rich text entry and lack of support for some types of data and data formats, such as ChemDraw files and computer code. Some users described difficulties editing Microsoft Office documents stored in LabArchives, which suggests that they may not have been aware of LabArchives’ Microsoft Office plugin which could likely improve their experience. This indicates that additional outreach and training by the ELN service team is needed to make users aware of features in the system.

The survey results provide some insights into barriers to adopting the ELN. Approximately one third of respondents to the survey were identified as non-users, i.e. individuals who had an account on the LabArchives system but had either never used it or had discontinued use. Dissatisfaction with the UI, preference for other tools, and lack of compatibility with specific data types were cited as key reasons for discontinuing use by the majority of non-users who had some experience using LabArchives. Among non-users with little to no experience with the

LabArchives platform, preference for another tool was also given as a common reason for not using LabArchives; but in this group, barriers such as time and effort to adopt a new system or incompatibility of a digital system for their specific research situation (lack of access to computers or devices that could be used at the bench) were also mentioned. A number of respondents in the survey, both users and non-users provided references to decisions and discussions about the ELN that occurred in their research groups in their written comments. In addition, most users in the survey indicated that the majority of members of their lab groups were also using LabArchives while most non-users in indicated that only a few to no other lab members were using it. Together, these findings suggest that adoption of the ELN generally involves a decision and effort by an entire lab group.

Appendix: Survey Questions

Since 2014, UW-Madison has provided researchers an Electronic Lab Notebook (ELN) service based on the LabArchives platform.
We would like to invite you, a UW-Madison researcher with an account on the LabArchives system (whether you are actively using it or not), to complete this survey. This will help us gauge the ongoing needs for a campus ELN service and better understand the pros and cons of the system from active users AND the barriers to its use by those that are not using it.
The survey consists of about 20 questions, should take 4-7 min to complete, and is completely anonymous unless you opt to share your name for follow-up discussion with us.

Thank you!
The ELN Service Team

Which of the following best describes your main research disciplinary area?
- o Agriculture and Life Sciences
- o Biomedical
- o Engineering
- o Physical Science
- o Social Science
- o Other

What is your current position at the UW-Madison?
- o PI/faculty
- o Graduate student
- o Undergraduate student
- o Post-doc
- o Scientist
- o Other/Staff
- o I am no longer with the UW-Madison.

Which statement best describes the type of documentation/records you require members of your research group to keep of their research?
- o I don't have any requirements
- o I have general requirements
- o I have specific requirements
- o Not sure or not relevant

Which statement best describes the type of documentation or records your PI/research advisor requires you to keep for your research? My PI . . .

o Doesn't have any requirements
o Has general requirements
o Has specific requirements
o Not sure or not relevant

Which of the following best describes your use of the LabArchives Electronic Lab Notebook system?

o I am currently using it
o I have used it in the past, but stopped
o I have logged in a few times but have never actively used it
o I have never logged in or used it

Do others in your research group/lab use LabArchives?

o No
o Yes, a few others use it.
o Yes, about 50% of the group uses it.
o Yes, nearly everyone in the group uses it.
o I'm not sure.

How long have you been using LabArchives?

o Less than 6 months
o Between 6 months and 1 year
o Between 1-2 years
o More than 2 years

How frequently do you use LabArchives?

o Daily
o Weekly
o Monthly
o A few times per year

What have you found to be the main benefits of using LabArchives?

_____

What have you found to be the main limitations or disadvantages of using LabArchives?

_____

Which features of LabArchives do you use? (Select all that apply)

- o Create rich or plain text entries
- o Attach data files
- o Link to data files in other locations
- o Use on mobile device(s) like phone or tablet
- o Search
- o Folder Monitor plug in (automatically finds and uploads files on lab servers)
- o Microsoft Office plug-in (synchs with local MS Office applications on your computer)
- o Microsoft Office online editor
- o Math equation editor
- o ChemDoodle drawing tool
- o Sign/witness pages
- o Share notebooks/data with members of my research group
- o Share notebooks/data with collaborators outside my research group
- o Export notebooks in PDF format
- o Export notebooks in HTML format

How effective is LabArchives for each of the following?

Very effective Moderately effective Not effective Not sure or not relevant

Keeping a complete record of research
Storing and organizing data
Sharing findings with others
Protecting confidentiality and/or intellectual property
Making research reproducible
Creating a long-term archive of research

What proportion of all the data that you create and use in your research do you upload (attach) into LabArchives?

- o More than 90%
- o 50 to 90%
- o 25 to 49%
- o Less than 25%

Is LabArchives the primary tool you use for recording your research?

- o Yes
- o No, I use other tool(s) as the primary means of recording my research (Please name/describe)
- o Not sure or not relevant

What are some of the reasons you stopped using LabArchives?

_____

Are there any factors that might make you consider using LabArchives again?

_____

Have you considered using LabArchives?

o Yes
o No
o Not sure or not relevant

What are some of the reasons you have not used LabArchives?

_____

Are there any factors that might make you consider using LabArchives in the future?

_____

Please list some of the tools you use to record your research. (E.g. software, paper notebooks, etc.)

_____

Taken together, how effective are the tools you listed above for each of the following?

Very effective Moderately effective Not effective Not sure or not relevant

Keeping a complete record of research
Storing and organizing data
Sharing findings with others
Protecting confidentiality and/or intellectual property
Making research reproducible
Creating a long-term archive of research

Since 2014, UW-Madison has provided support (funding and administration) for an enterprise Electronic Lab Notebook (ELN) service. What is your level of agreement with the following statements about continued support for an ELN service over the next 5-8 years?

Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree

It's important that UW continue to provide a campus ELN.
It's important that UW continue to use LabArchives as the campus ELN.
It's important that UW look into alternatives to LabArchives for the campus ELN.

In your opinion, what other tools or services should UW-Madison provide for research data?

_____

Hypothetically, if UW-Madison discontinued support for the campus ELN, which of the following options would you pursue? (Select all that apply)

- o Find a source of funds to pay for ELN license(s) myself
- o Use an ELN that offers a free version
- o Use paper lab notebooks or other paper methods
- o Other (Please describe) _____

Use this space to enter any additional comments. If you would like to discuss ELNs or other digital research tools in more detail with the ELN service team, please provide your name and email address.

_____