ADOPTING A PAPERLESS LABORATORY REPORT MANAGEMENT SYSTEM: A FEASIBILITY STUDY

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This article summarises my Professional Development Programme (Teaching) (PDP-T) practicum on implementing a paperless laboratory report management system using the National University of Singapore's Integrated Virtual Learning Environment (IVLE) as the platform.

Background and Objective

The laboratory report is an important component of student assessment in practical modules. In the Department of Chemistry, students are currently required to submit both hard and soft copy versions of their laboratory reports. The soft copy version is an electronic document containing the laboratory report typed by the student; it is uploaded to the "Student Submission" folder in the IVLE Workbin for the lecturer to grade and conduct a plagiarism check. The hard copy version includes, besides the laboratory report, a handwritten datasheet, a spectrum printout or other documents related to the practical session. Students submit the hard copies to the laboratory staff, who sort the reports according to the class roster and hand them to the lecturer for grading. After grading, the lecturer returns the reports to the laboratory and informs students to collect their reports so that they can view the grades and comments.

Benefits of going paperless

One of the logistical challenges of this process is the effort needed to sort and transport these hard copies. Every semester, there are always a number of reports that are left uncollected in the laboratory, which also takes up storage space. As such, it would be timely to implement a paperless laboratory report management system by which students submit only soft copies of the reports and grading can be done on these electronic documents.

Adopting a paperless approach is beneficial for several reasons. For one thing, most students nowadays use computers to type their reports. This method would ensure that tasks such as report submission (by students) and the downloading and grading of these reports (by the lecturer) can be achieved without

either party having to be physically on campus. This is an advantage if the lecturer plans to conduct online group discussions or even a virtual laboratory in future. In addition, the lecturer would be able to easily conduct online plagiarism checks on soft copies of the reports, which could deter students from copying other people's work and in the long run, also foster independent thinking. McDowall (2004) and Giles (2012) have highlighted the benefits of this approach in their studies of similar but more comprehensive paperless systems. These include significant reductions in cost (e.g. incurred by paper waste and logistics cost) and paper work, as well as increased efficiency (Giles, 2012).

In this case, the objective of this practicum is to test the feasibility of putting in place a paperless system of managing and grading laboratory reports using IVLE as the platform. We compared the lecturer's input of time and effort when using the conventional method (i.e. grading the hard copies) against the paperless method. Students' experiences with these two methods were also surveyed and compared.

Methodology

As the lecturer of the module CM2192 "Experiments in Chemistry 3" in Semester 2 of AY2013/14, I chose two experiments (Experiment 8 "Rovibrational Spectrum of Hydrogen Chloride" and Experiment 9 "The Electronic Absorption Spectrum of Iodine") in this module to conduct this practicum. These two experiments are both about molecular spectroscopy, and are similar in terms of the level of difficulty and the page limit for the respective laboratory reports. A class of 98 students were divided into two groups (Groups 1 and 2). For each group, both submission and grading were conducted using the conventional method for one experiment, and the paperless method was administered for the other experiment. (see Table 1).

Table 1. Methods (conventional or paperless) used for laboratory report management.

Group (Number of Students)	Experiment 8	Experiment 9
Group 1 (51)	Paperless	Conventional
Group 2 (47)	Conventional	Paperless

Following the paperless method, students were instructed to upload electronic versions of their laboratory reports to the "Student Submission" folder in the IVLE Workbin. Since each report also included a spectrum printed in the laboratory, students were given the option of either uploading the scanned or photographed files of the spectrum printout as an attachment, or simply submitting the spectrum printouts in hard copy to the laboratory if they had no access to a scanner or smartphone. The latter option was given to minimise the extra cost students might incur if they had to purchase additional equipment for the soft copy submission.

As the lecturer, I first collected the spectrum printouts submitted to the laboratory in hard copy (only a few copies). I downloaded all the reports to my computer before starting to grade them. When grading, I read each report on the computer screen and inserted my comments into the electronic documents by using either the "Comment" tools in Microsoft Office Word or the "Comment and Markup" tools in Adobe Acrobat Pro. When it came to grading the spectrum printouts, I referred to either the electronic attachments or the hard copies handed in. After grading, I keyed in the grade in the "Comment" page of the student's file in the IVLE Workbin, and uploaded the annotated file as an attachment. (see Figure 1) The "Student Submission" folder was set in such a way that each student could only view his/her own grade and file. In IVLE, another tool called "Annotate" also allowed the lecturer to add comments in the student's document. However, this tool was not used in this practicum because it required online operation and was less convenient than editing the document offline.

Figure 1. The "Comment" page on IVLE in which the lecturer keys in the student's grade and includes the annotated file as an attachment.
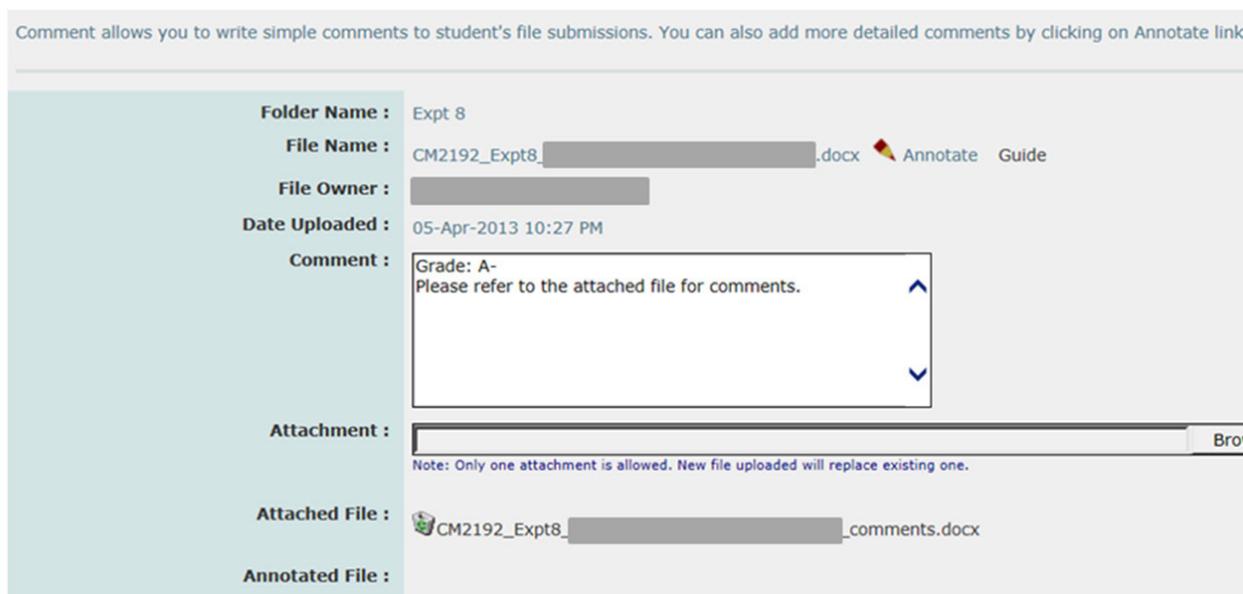
Results and Feedback

Table 2 compares the two methods and their impact on the learning environment as well as the parties involved in the laboratory session, namely the instructional team (comprising the lecturer and laboratory staff) and the two groups of students.

Table 2. Comparison between the conventional and the paperless methods.

	Conventional	Paperless
Lecturer	6 minutes per report (grading only)	8 minutes per report (including downloading, grading and uploading)
Laboratory Staff	Sorting and distributing	N.A.
Student	Time and cost for printing	N.A.
Environment	4 pages = min. 2 sheets of paper per report	N.A.

Feedback from the lecturer and laboratory staff

On average, it took me (the lecturer) six minutes to grade a report on hard copy (we recorded the timings with a stopwatch), which included reading it, writing brief comments in the margins and inserting a grade on the front page. This increased to eight minutes when I used the paperless method. This is because the time required to download and upload soft copies of the report had to be taken into account, even though the time spent writing the comments was shorter, since for me typing tends to be faster than writing. To save more time, I made a document with a list of common comments from which the selected comment could be copied to the student's report when needed.

As for the laboratory staff, they indicated through informal conversations with the lecturer that they preferred the paperless method because they no longer needed to sort and distribute hard copies of the reports.

Feedback from the students

A survey was also conducted to evaluate students' experiences with the two methods (shown in Table 2). The survey results are reflected in Tables 3 and 4.

According to the results collated in Table 3, a larger portion of students gave a positive response to the change, either preferring the paperless method (43.3%) or feeling neutral about it (33.3%). The responses shown in Table 4 also indicate this, with the majority of respondents agreeing that the paperless method saved them time (86.6%) and money (66.7%). In the survey, some students also gave qualitative comments that the paperless method saved them the trouble of going to the laboratory to submit and collect their reports, and they were able to review the comments of the reports anywhere with their smartphones. Some also considered the paperless method "an environmentally-friendly way of marking the reports". In terms of negative responses, only a small percentage of respondents considered scanning or taking a photograph of the spectrum printout to be time-consuming (30.0%) and costly (3.3%).

Table 3. Students' responses on whether they prefer the conventional or paperless method. (Response size: 30)

Rank	Percentage
I like the conventional method better.	10.0%
I like the paperless method better.	43.3%
I do not have any preference.	33.3%
Skip	13.3%

*Note: Students had to answer the following multiple-choice question:

Overall, which of the two methods do you prefer?

- **The conventional method** (submitting/collecting hard copy report + spectrum in the lab, and uploading the soft copy of the main report to IVLE for plagiarism check), or

- **The paperless method** (uploading soft copies of both the report and spectrum to IVLE, and downloading reports with grade and comments).

Table 4. Students' responses on their experiences with the two methods. (Response size: 30)

Please indicate how much you agree with the following statements by selecting from the list below.					
Options	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The paperless lab report submission saves me time of going to the laboratory to submit and collect the lab report.	0.0%	0.0%	13.3%	43.3%	43.3%
The paperless lab report submission saves me money spent on printing.	0.0%	3.3%	30.0%	56.7%	10.0%
Scanning or taking photograph of the datasheet/spectrum for the paperless lab report submission is time-consuming.	6.7%	13.3%	50.0%	26.7%	3.3%
Scanning or taking photograph of the datasheet/spectrum for the paperless lab report submission costs me extra money.	10.0%	46.7%	40.0%	0.0%	3.3%

Concluding Reflections

The paperless method of managing laboratory reports has been tested and found to be feasible. According to the qualitative and quantitative feedback, this method saved students and laboratory staff time and reduced wastage of paper, even though it required slightly more work for the lecturer. However, we found limitations in the methodology which can be addressed when we implement this system for future laboratory sessions. For instance, the datasheet and spectrum printouts could be digitised to facilitate easy uploading to the IVLE. The lecturer could also recommend that students submit their reports in a certain file type based on his/her preference. For example, I prefer students to submit their reports as Word documents rather than as PDFs, because it is easier and faster to insert comments into the former. In terms of evaluating the effectiveness of future runs of this method, the qualitative and quantitative feedback could be substantiated by other sources of data (e.g. focus group sessions with students). To further refine this approach, one could also look into harnessing the benefits of going paperless by conducting online group discussions or a virtual laboratory for subsequent sessions.

References

Giles, J. (2012, January 26). Going paperless: The digital lab. *Nature, 481*, 430-431. Retrieved from *http://www.nature. com/news/going-paperless-the-digital-lab-1.9881*.

McDowall, R.D. (2004). Designing a paperless laboratory. *Scientific Computing & Instrumentation, 21*(12), L8-L14. Retrieved from *http://www.scientificcomputing.com/articles/2004/10/designing-paperless-laboratory*.

About the Author

Dr Xu Hairuo teaches physical chemistry and practical modules in the Department of Chemistry. She has a keen interest in enhancing her students' learning experiences and continuously seeks new and more effective ways of managing teaching and assessment in her modules.