



Spence, A., McCutcheon, V. and Donaldson, M. (2020) University of Glasgow Electronic Research Notebook Case Study. Project Report. University of Glasgow, Glasgow.



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Deposited on: 15 July 2020

University of Glasgow Electronic Research Notebook Case Study

In 2018-2019 the University of Glasgow used a Jisc grant to run a package of work to provide evidence of user requirements for electronic research notebook tools for the [Jisc Open Research Hub](#) project and to inform longer-term plans for the University of Glasgow.

Summary

We organised several workshops and notebook software trials to collect user requirements for electronic research notebooks, gauge researcher interest and current usage, and understand barriers inhibiting uptake of notebook tools.

Key findings:

- University researchers and departments are already using a range of electronic research notebook tools in a variety of ways.
- Many researchers and teaching departments are keen to start using electronic notebooks. Barriers include too many tools to evaluate; time required to set up and learn new software; lack of support; most tools designed principally for Life Sciences.
- No one tool currently fulfils all essential user requirements identified during the project.
- Implementing notebook software works best when it is planned, structured and supported.

Background

In 2012 and again in 2016, we investigated electronic notebooks and reported our findings to senior management. The University did not pursue the idea at the time. In 2018 we wondered if the time was right to pursue this again. Electronic notebooks would support the [University's strategic aims 2015-2020](#) to 'provide state-of-the-art facilities, equipment and services for research and teaching' and 'invest in the digital infrastructure necessary for managing modern research datasets'¹. This, combined with funder interest in notebook retention and access, led to this collaborative activity with Jisc.

Original Aims

- Explore current issues and attitudes around electronic and paper research notebook usage
- Identify possible solutions and best practice
- Explore requirements for interoperability between active storage and repositories
- Demonstrate and gather views and guidance on electronic research notebook software
- Gather user requirements for notebook tools, including metadata requirements and examples of subject-specific metadata
- Provide some use cases of electronic notebook usage
- Digitise some sample paper research notebooks and report observations and issues encountered
- Encourage engagement with Jisc requirement for a test group to test integration of electronic lab notebooks with the Jisc Open Research Hub.

Activities

1. Investigate what is already happening locally and nationally.
2. Run four open national workshops on paper and electronic notebooks usage, issues and attitudes; organise demonstrations of notebook tools, given by existing users.
3. Run trials of notebook software.
4. Digitise a sample paper research notebook: report outcomes and issues encountered.

5. Gather user requirements for notebook tools, metadata and integrations with other tools and equipment.

1. Current local/national situation

The prevalence of digital research resources, machine-generated data and online teaching mean paper notebooks are not necessarily the most practical means of documenting research and learning. Although electronic research notebooks have been widely adopted in science-based industries and pharmaceutical companies, due to compliance and regulatory requirements, their uptake in academic research is limited. Usage within Arts and Social Science is particularly low. Some subjects have independently implemented notebook tools e.g. groups within University of Glasgow's Chemistry department use SciNote, but only a few institutions have embedded central support for electronic notebooks e.g. The Babraham Institute implemented OneNote as an institutionally-supported research notebook in 2019.² During our investigations, we collaborated with other organisations actively exploring electronic research notebooks, discussing issues, sharing outcomes and considering potential next steps.

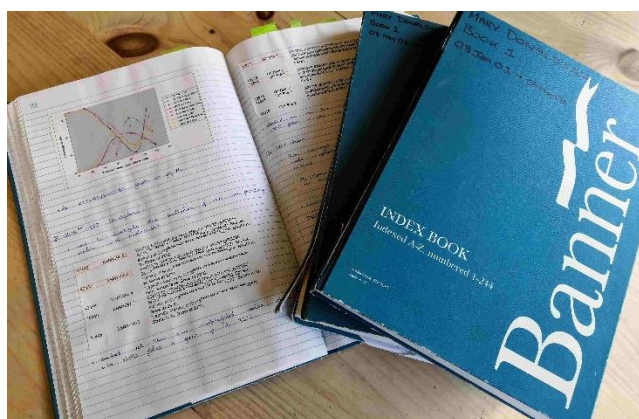


Fig.1 paper research notebooks

2. Workshops and software demonstrations

We organised a series of open, national workshops to gather views on electronic and paper notebooks; identify good practice; and ascertain requirements. Current electronic notebook users demonstrated tools and answered questions. Participants included university researchers, support and teaching staff, and students.

Workshop One (August 2018) took the form of an initial factfinding meeting with a group of researchers from The University of Glasgow's School of Physics and Astronomy, exploring their use of both electronic and paper research notebooks. At that time, 70-80% of School staff used some kind of electronic documentation tool. Particle physicists used tools supplied by the European Organisation for Nuclear Research (CERN); researchers in Gravitational Waves employed a variety of tools e.g. LabArchives, WordPress. Most Optics researchers preferred paper notebooks, because they frequently document their research via drawings: drawing functionality is not well-supported in many current notebook tools. The School was keen for students to use electronic notebooks – a potential way to enhance their future employability. Staff had trialled RSpace and OneNote and planned to implement Python notebooks for undergraduate students (this implementation has since happened).

Workshop Two (November 2018) gathered information on current notebook usage and user requirements for electronic notebooks. We ran the workshop twice, in Glasgow and London. Researchers from a range of disciplines were invited to share:

- how they currently used paper and/or electronic research notebooks
- any concerns they had e.g. loss of data
- what they would like e.g. from their organisation, or a tool
- subject-specific requirements e.g. particular functions, integrations
- views on sharing notebook contents.

Several participants were using or had tried electronic tools, ranging from online ‘to do’ lists to formal notebooks. None was institutionally implemented.

Workshop participants were keen to see demonstrations of notebook tools. Therefore, in **Workshop Three** (Spring 2019) researchers, research support staff and students demonstrated electronic notebook tools, discussing why they had chosen that tool, how they had configured it and used it, positive features and drawbacks. We ran the workshop twice, in Glasgow and Sheffield: different tools were discussed at each venue.

Key observations from current users about implementing a notebook tool:

- It does take time to set up and learn notebook software but the time is well spent
- Having local champions helps to encourage adoption and support new users
- Widescale implementation may have resource implications e.g. adequate provision of laptops or tablets
- Web-only tools require reliable wi-fi
- New users can be put off by tools which look too complicated.

Workshop Four (November 2019, Durham) included a case study on the University of Glasgow School of Life Sciences’ trial of RSpace, OneNote and Microsoft Teams. Attendees debated essential features for notebook tools. Requirements are discussed below.

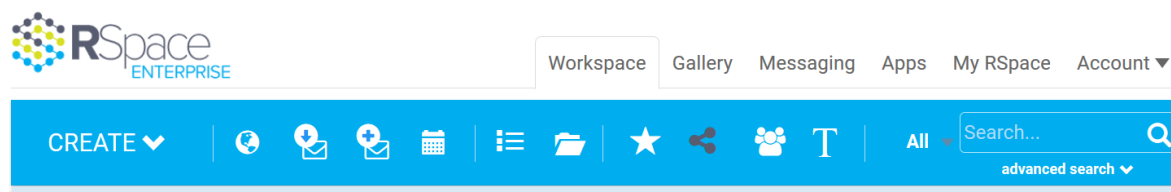
The workshops presented a rare opportunity for research, teaching and support staff to talk about documenting research. Some felt it would be helpful to share good practice or see how others organise their research. Some had reservations about sharing notebook contents, especially beyond their workgroup, because they used their notebooks to document personal content and confidential meetings, as well as research.

We wanted to ensure that our research into notebook usage encompassed several disciplines so in July 2018 we e-mailed a brief, informal survey on paper notebook usage to Arts researchers within the University of Glasgow. 53 people responded. 77% of respondents used a paper notebook at least some of the time to record research-related notes. Of this group, 45% subsequently transferred some or all of their notes into digital format for ongoing use or to mitigate against loss. Users found paper notebooks convenient or more compatible with their research methods. For some, writing by hand facilitated free thinking and idea development. Consequently, paper notebooks were still considered an important working tool for three-quarters of the respondents, but the survey highlighted users’ concerns about the potential impact of data loss.

3. Software trials

Our notebook software trials ran from May-December 2019. We kept the test group fairly small as we had limited capacity to manage the trial. Around one hundred students and thirty University of Glasgow staff tested RSpace, OneNote and/or communications software Microsoft Teams.

RSpace

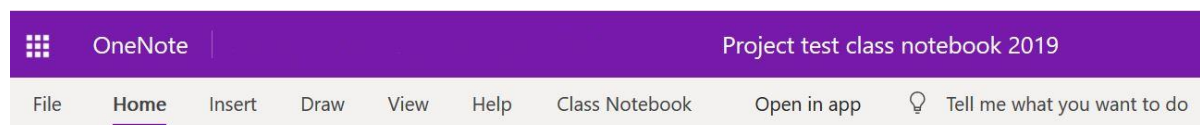


We trialed the Enterprise edition of RSpace's research notebook software (<https://www.researchspace.com/>), thanks to the supplier. Some people also tested the free Community version. Unexpectedly, most interest came from teaching groups, rather than research teams. The School of Life Sciences wanted fourth-year undergraduates to start using electronic notebooks to help improve their employability, prepare them for workplace-based research and enable teaching staff to assess student project documentation more fully.

We decided to install RSpace locally on University servers. This enabled testers to use single sign-on and evaluate how RSpace integrated with Office 365, storage, etc. Due to other demands on key IT staff time, it took a while for the RSpace installation to be fully configured, which impacted on testing. A cloud instance managed by the supplier would have been an alternative set-up for testing but would have lacked the integrations.

For our triallists, managing access and supervision through work groups and user roles e.g. Principal Investigator worked well. Sharing options e.g. individual page or whole notebook facilitated collaboration within and beyond their workgroup. Integrated online resources such as Protocols.io streamlined work. Opinions were divided about RSpace's workflows: some found them too inflexible, others liked their structure. RSpace's gallery feature proved especially popular with some testers: a space where data and images can be stored, accessed, exported and easily incorporated into notes. Some Life Sciences students described RSpace's interface as 'daunting' and found it very difficult to familiarise themselves with all the functions, although RSpace's introductory tutorial proved valuable for getting started. The students considered that postgraduates or final year undergraduates would make best use of RSpace's functionality. Online access via any device was appreciated by users, although offline access would have mitigated problematic wi-fi connectivity.

Microsoft OneNote

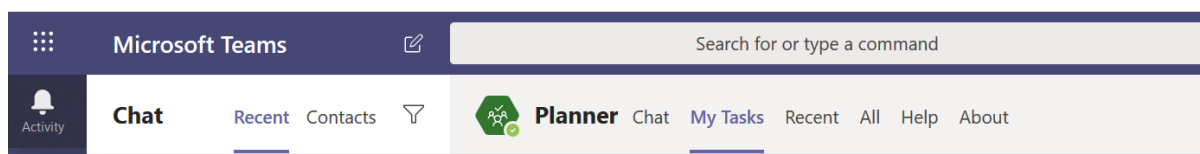


OneNote is a generic notebook tool bundled with Office 365. We produced an [introductory guide](#) to OneNote and shared this via our [Research Notebooks blog](#) and the University website to encourage staff and students to try the software. OneNote was demonstrated during Workshop Three.

Triallists found OneNote's user-friendly interface easy to navigate, aided by familiarity with other Microsoft products. They felt it provided a flexible, straightforward workspace, a 'plethora' of essential functions and good integrations. Substantial storage and both online/offline access supported productivity. For the Life Sciences students, OneNote's key feature was its co-editing function: multiple people can edit the same document in real time. However, sometimes edits did not synchronise properly, mainly due to connectivity problems. OneNote displayed a warning message when this happened, allowing the problem to be

resolved manually. One downside is that content cannot be locked to prevent further editing, an important consideration for some users.

Microsoft Teams



Some users tested Teams with RSpace or OneNote. Separate chat channels for different topics kept conversations relevant. Granular notification control was useful, but Teams does not alert senders when message delivery fails or re-send failed messages, which frustrated users. Again, connectivity issues caused synchronisation issues between web and desktop versions of documents and during group editing sessions. Some users reported that it was not always easy to find files within the Teams filestore. Also, with some files stored in OneDrive and others in Teams, users became confused about where to find their files.

Overall, the Life Sciences students involved in the trial reported that they documented their work more thoroughly and improved their digital skills while using the notebook tools. A staff member commented that using dedicated notebook software encouraged her to document her research in a clear, structured way and helped her produce professional-looking content.

4. Trial digitisation of a paper research notebook

Conscious that many researchers have large stacks of legacy paper notebooks, we wanted to explore whether digitising paper notebooks would be viable or useful. Therefore, in November 2018, we undertook a trial digitisation of a paper research notebook containing pencil and ink notes, tables and diagrams, along with glued-in computer printouts and photographs. The notebook owner also shared some related experiment data files. Using an A3 flatbed scanner, we experimented with different scanning resolutions to achieve an optimal balance between readable content and manageable file sizes. We created three outputs for feedback: a folder containing digitised notebook pages saved as individual image files; a multi-page pdf; and a multi-page file in tiff format, interspersing notebook pages with related research data. The researcher preferred the multi-page pdf, which he could annotate, turning it into a dynamic document. The main drawback was that the scanned content was not searchable, as our scanner did not offer optical character recognition.

This was a useful exercise. An overhead book scanner with optical character recognition would generate more usable output more efficiently, but staff time for digitisation and ongoing preservation of the digitised output, storage requirements and cost of this time and storage would be significant factors to consider if we want to pursue digitisation further.




Fig.2 Overhead book scanner

5. User requirements

A key aim was to understand what functionality researchers, research support, teaching staff and students consider essential, useful or desirable for electronic research notebooks.

Requirements were explored during each workshop. We collated responses, shared them through the blog, invited feedback and augmented/refined the list throughout the project. The notebook requirements covered technical functions, storage, security, compliance and collaborative working. In Workshop Four, participants discussed a list of forty requirements informed primarily by the work at Glasgow University, The Gurdon Institute (University of Cambridge) and Delft University of Technology. Functions agreed as universally essential included annotation tools, read/write access for internal collaborators and the ability to export notebook contents in standard formats. Where possible, administrative staff tested each proposed requirement in RSpace and OneNote and documented the outcomes.

Once the workshops were completed, we prioritised our [list of approximately fifty requirements](#) using the MoSCoW prioritisation methodology, informed by workshop feedback. The prioritised list was published via the Research Notebook blog for community feedback.



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21/11/19 We plan to clarify the meaning of these ideas. If you think a key generic requirement is missing you can add a comment. We hope to have some community discussion which we will advertise via the Jisc mail list <https://www.jiscmail.ac.uk/cgi-bin/webadmin?A0=RESEARCHNOTEBOOKS>.

THIS IS AN INFORMAL LIST OF SOME POSSIBLE REQUIRMENTS FOR RESEARCH NOTEBOOKS		CATEGORY	PRIORITY
To provide a user friendly interface	Functionality	1 Must Have	
To allow notebook content to be exported in standard formats	Functionality	1 Must Have	
To provide a search tool	Functionality	1 Must Have	
To provide a sorting tool to allow sorting by author and/ or date and/ or research group	Functionality	1 Must Have	
To provide a tool which allows work with equations	Functionality	1 Must Have	
To provide a tool that allows barcode production and reading for experimental samples	Functionality	1 Must Have	
To provide a tool that prevents accidental deletion of data	Functionality	1 Must Have	
To allow the incorporation of metadata that is downloadable and well defined	Functionality	1 Must Have	
To permit supervisory access to notebooks/control of accounts	Collaboration	1 Must Have	
To allow different levels of access and editing capabilities (including dual, full rights access)	Collaboration	1 Must Have	
To provide collaborative software for intra, inter and public sharing of research data and files	Collaboration	1 Must Have	

Fig.3 Snapshot of part of the prioritised list of requirements

As other institutions have discovered, users' essential requirements differ widely and can be contradictory. Version control, document signing and supervisory/PI access are crucial features for some users, but of no interest to others. Controlled workflows can promote good practice or inhibit note-taking. Software designed principally for Life Sciences may alienate those in other disciplines. No existing 'out of the box' tool can accommodate all of these differences. Institutions may need to offer a choice of tools or adopt a modular approach, incorporating multiple tools.

Outcomes

This project enabled us to talk to researchers, research support and teaching staff and students in a number of institutions about how they document their research; the tools they use; challenges, benefits and concerns relating to both paper and electronic notebooks; and what a user-friendly electronic notebook would look like to them. We have collected and tentatively prioritised their requirements and have shared these with Jisc and the wider community. Jisc plans to use this data to develop a procurement framework for research notebooks, one strand in a broader purchasing service. Vendors will be able to submit their tool to Jisc to be assessed against user requirements: potential users can then review the Jisc outcomes, rather than independently assess all possible tools. Jisc hopes that the framework will 'help towards the adoption of open standards and interoperable solutions'.³ Jisc launched

its [purchasing service for research outputs repository systems](#) in May 2020;⁴ they hope to introduce their framework for research systems later in 2020.

Workshop participants valued the tool demonstrations and guidance on implementing and optimising a tool. We have shared the outputs via the blog [University of Glasgow Research Notebooks blog](#).

Lessons learned

Choosing a tool

Many researchers are keen to use electronic notebook tools. Teaching departments want to implement electronic notebooks to develop students' documentation skills and enhance their employability. However, prospective users are overwhelmed by the extensive selection of similar-looking products and lack sufficient time to review and trial potential options.

Requirements

User requirements are diverse. There is currently no single tool which institutions could provide centrally to fulfil everyone's needs. A different approach is therefore necessary to facilitate electronic notebook use.

Implementation

Implementing electronic research notebook software takes time, careful planning, commitment and adaptability. Training, advice and peer support are important to ensure take-up and sustained use. Sufficient supporting resources e.g. pcs/tablets need to be provided. However, people who have moved to electronic notebooks say the time invested in implementation is definitely worthwhile.

Technical Set Up

Investment is required to ensure that any tools are set up appropriately and have IT specialists with the right skills available to support them.

Next steps

We have turned the [University of Glasgow Research Notebooks blog](#) into an open space for research notebook information sharing. We encourage people to read the list of user notebook requirements and add their views. The Jisc [research notebook mailing list](#) continues as a forum for discussion. We are contributing to an informal steering group with colleagues from other institutions and Jisc to co-ordinate activities and research, maintain momentum and reach out to similar initiatives. We welcome input and encourage anyone interested in research notebooks to join the discussion.

During the COVID-19 pandemic, Jisc is collecting researchers' stories about how they are continuing with their research while working remotely, with particular reference to research notebooks. Jisc plans to establish a community of practice for research leaders interested in technology.

Advocates of electronic research notebooks and related tools within the University continue to refine and expand their use. For example, one research group has adopted Teams as their core work platform. Instant messaging is preferred to e-mail, makes file sharing easy and facilitates focused conversations within/beyond the group and University. Many apps can be integrated e.g. OneDrive, Zoom, Trello and OneNote (which the group uses as a collaborative

research notebook). If a researcher leaves, their files remain accessible. Group members find this an efficient, effective way of working. Teaching departments are introducing research notebook tools. Undergraduate students in the School of Physics now use Python notebooks to record research notes and carry out tasks; some classes submit lab reports using Jupyter notebooks. Our workshop demonstrators emphasised that peer support and role models underpinned the successful adoption of electronic notebooks. We are therefore keen to find ways to share this expertise and enthusiasm within our institution in a time-efficient manner to engage and support new users. The University of Glasgow's [Code of Good Practice in Research](#)⁵ requires researchers to properly document their research and ensure that research data and research notebooks are available for ten years post-completion of a project (section 3.6). As researchers move away from paper notebooks, they need guidance and support to select and implement suitable, robust, electronic tools which will assist them to fulfil University and sector expectations for well-documented, accessible research.

As well as offering generic guidance on using OneNote as an electronic research notebook, we have secured a budget for a small number of commercial electronic research notebook software licences. We hope to expand upon this with further central support for notebook tools. It is important for us to consider effective integration with other tools and services and keep an eye out for new developments. For example, we are also developing our digital preservation service and the long-term preservation of notebook content will be an important consideration. Further evaluation of the business benefits and options will need to be done.

Resources

We have created a list of notebook software and other tools which we have encountered during this project. The list is available under outputs on our [Research Notebooks blog](#).

Acknowledgements

We would like to thank the workshop participants for their valuable input. We also appreciate the assistance of researchers, support and teaching staff, students and colleagues in several institutions who shared experiences and expertise, offered feedback and trialled notebook tools. Thanks are also due to Jisc for their contribution and support.

This work was supported by the Jisc grant number 4811.

Image credits

Fig. 1: Mary Donaldson.

Fig. 2: Jodi Green, made available under Creative Commons licence CC BY-NC-ND 2.0.

CRedit

Mary Donaldson: investigation, writing – review and editing

Valerie McCutcheon: conceptualization, funding acquisition, investigation, project administration, writing – review and editing

Alison Spence: investigation, writing – original draft

Appendix One

Tables 1 and 2 list paper and electronic notebook benefits and concerns identified by project workshop attendees and software triallists.

Table 1

Paper research notebook benefits	Paper research notebook concerns
<ul style="list-style-type: none"> ○ Flexible notetaking, good for sketches and diagrams ○ Unstructured, customisable ○ Facilitates idea development and free thinking ○ Portable ○ Easy to use ○ More convenient for certain research activities e.g. in the field 	<ul style="list-style-type: none"> ○ Legibility (handwriting) ○ Notes written in language other group members do not read ○ Vulnerable to loss: hard to back up ○ Risk of damage or contamination ○ Security (theft, access to contents) ○ Preservation: <ul style="list-style-type: none"> - long-term storage - physical deterioration ○ Not searchable ○ Difficult to share/re-use contents ○ Not linked to software or datasets ○ Not always at hand when required ○ Does not facilitate collaborative working

Table 2

Electronic research notebook benefits	Electronic research notebook concerns
<ul style="list-style-type: none"> ○ Encourages good recordkeeping ○ Research notes all in one place ○ Integrates with other systems ○ Links to external documents/data ○ Version control and audit procedures ○ No need to transcribe paper notes ○ Searchable, can tag/filter contents ○ Protection against loss: contents backed up ○ Easy to store ○ Promotes standard practices within team ○ Create/share templates ○ Facilitates supervision for teaching and PIs ○ Facilitates collaboration/data sharing ○ Supports reproducibility of research and access to data (Open Access) 	<ul style="list-style-type: none"> ○ Cost ○ Learning curve ○ Lack of training/support ○ Time to set up ○ Structure does not suit all users ○ Content portability (export options/formats) ○ Incompatibility with other systems ○ Connectivity: syncing across devices/users, offline access ○ Content sharing: others have access to unrefined data/thoughts ○ Security: back-ups, access, data protection ○ Location of data storage (compliance, funder requirements) ○ Risks associated with long-term preservation of digital files ○ Electronic devices not accepted in all research environments

	<ul style="list-style-type: none"> ○ Lab environment: adequate space, need appropriate devices, contamination ○ Access/usage issues if different software is used in teaching and placement labs ○ Too science-orientated ○ Choice overwhelming ○ Provider going bust
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¹ University of Glasgow (2015) *University Strategy 2015-2020*:22, 28.

² Jisc (2020) 'Turning the page on paper notebooks creates a digital dilemma', 17 Feb 2020.

<https://www.jisc.ac.uk/news/turning-the-page-on-paper-notebooks-creates-a-digital-dilemma-17-feb-2020> .

³ Ibid.

⁴ Heeley, M. (2020) 'Jisc launches Research Repositories Dynamic Purchasing System', 4 May 2020

<https://scholarlycommunications.jiscinvolve.org/wp/2020/05/04/jisc-launches-research-repositories-dynamic-purchasing-system/>

⁵ University of Glasgow (2018) *Code of Good Practice in Research*.