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WE WILL MEET YOU WHERE YOU ARE:

The Development and Evaluation of Tailored Training for the Management of Research Data

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While demands on researchers to be acquainted with research data management (RDM) practices keep increasing, there are few formal opportunities for such training across academic curriculums. At a large research university, an RDM specialist and two liaison librarians partnered to create a new RDM training and outreach program. They measured the success of their training with a pre- and post-test study of an instructional intervention tied to clearly defined learning outcomes. This paper will focus on the curriculum of the workshops, outreach to researchers, and the results of the intervention. The paper will also discuss how librarians can introduce RDM in their instruction at different levels from undergraduate studies to faculty research

INTRODUCTION

While research data management (RDM) has grown to become an important part of workshop offerings in universities, few information literacy frameworks directly address data literacy. The ACRL *Framework for Information Literacy in Higher Education* provides knowledge practices and dispositions that can help librarians frame their instruction, however, these indicators focus on information sources broadly and do not specifically address data.[1] Some disciplinary sections of ACRL, such as the Politics, Policy and International Relations Section, have created their own companion documents to the *Framework* to help fill this gap and engage with data literacy.[2] At the McGill University Library, the research data management specialist and two subject librarians collaborated to create a series of research data management workshops. We used the *Framework* as a starting point to create learning objectives and evaluate students' learning.

LITERATURE REVIEW

Many institutions offer RDM training for various audiences (e.g., undergraduates, graduate students, faculty members, etc.) and tailored for various disciplines and contexts. RDM training is typically offered as part of library service models similar to data librarianship, where training is open and not curriculum dependent. In this way, RDM training typically also reflects the "one shot" model of instruction, where librarians offer a workshop or a series of workshops rather

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than a full course or semester-length curriculum. The mode of delivery for these types of workshops includes a range of approaches, such as asynchronous online instruction modules, conventional in-person instruction, and synchronous online instruction.

One-shot Instruction

One-shot instruction often refers to a type of library instruction where librarians provide information literacy sessions to students in a single session or workshop. While it is one of the most common methods of academic library instruction, it has always been under scrutiny with various opinions that support its value in learning, while others question the breadth of its effect. The efficacy of one-shot instruction has long been a question in terms of student learning. There have not been many significant studies produced to show whether one-shot instruction has an impact on lasting retention.[3] A 2022 meta-analysis found 11 usable studies utilizing varying methodologies on measuring the effectiveness of one-shot instruction.[4] Authentic assessments were found to yield smaller effect sizes than tests, which suggests that one-shots that are targeted at specific skills to be measured on a test are more likely to have an effect.[5] Cook also noted that the sparse literature on the effectiveness of library instruction sessions presents challenges to the validity of the meta-analysis.[6] To have a better understanding whether librarian-run one-shots have impact on learning outcomes, there should be an increased focus on robust assessments, including those with statistical analyses.

RDM Training

The issue of assessments relying on statistical analyses for one-shot instructional sessions related to information literacy is also relevant in the context of RDM training. For example, a recent study found that there have been only four empirical intervention studies related to RDM training, and that two of these studies focused on RDM training for librarians, one focused on an embedded training in an undergraduate course, and the fourth focused on a for-credit RDM training within a graduate studies program.[7] One main takeaway from this study is that more intervention studies, relying on statistical analyses, are needed with regard to understanding the effectiveness of RDM training.

Overall, there are four recent studies that have focused on providing an overview of the existing literature related to RDM training.[8, 9, 10, 11] First, a recent literature review article identified an increase in demand for RDM training internationally.[12] This study found that many institutions offer introductory RDM training and that the demand is high among both STEM and non-STEM disciplines. Second, a systematic review conducted in 2020 of research related to RDM training found 28 studies published on RDM training between 2007 and 2019.[13] In general, this synthesis study found that most RDM training is offered by librarians via a mix of discipline-specific and general topics. This study also found four general categories related to measuring positive impact of the RDM trainings, including observations by the trainers related to trainee participation and engagement, an increase in future demand for or registrations for RDM training, self-reported increases in knowledge or understanding of RDM by participants, and self-reported positive feedback about the training by participants. In addition, this study found that RDM training is typically adjusted for audience knowledge level and discipline-specific needs. Finally, this study identified two additional themes from the literature, which include an emphasis on practical outcomes for attendees of RDM training and relying on collaborations to develop the training with varying relevant internal stakeholders.

Two other recent studies focused on quantitatively evaluating the effectiveness of RDM training in different modes and according to varying pedagogical approaches.[14, 15] For example, one study implemented an evaluation of an intervention focused on different styles of teaching or pedagogical approaches for online RDM instruction and found that interactive activities are related to higher post-training knowledge scores.[16] Another study evaluated online RDM instruction for graduate student using an experimental research design, where graduate students were assigned to an intervention group receiving online RDM instruction for four hours or a control group that did not receive training. The results of this study are based on a comparison of knowledge assessment scores between both groups for pre- and post- test scores. The knowledge assessment implemented in this study

was designed based on best practices related to RDM across the research data lifecycle model.[17] The main finding of this study is that RDM skills and knowledge depend on disciplinary training.

RDM CURRICULUM

Using the Framework for Information Literacy in Higher Education

As previously stated, the ACRL *Framework* does not provide specific knowledge practices and dispositions related to data literacy. However, it does provide good indicators that can be used to create learning objectives related to finding, using, and understanding sources. We chose the Frames "Information Creation as a Process" and "Research as Inquiry" to design the workshops. "Information Creation as a Process" was particularly helpful to help us highlight how data is created in different fields and how researchers can shape how data will be used and understood through the decisions they make related to their research projects. We used "Research as Inquiry" to describe how data can be organized, shared, and used in an ethical and legal manner. We initially created five core RDM workshops: introduction to research data management, how to write a data management plan, research data management in depth, make your data open access, and RDM in the Humanities and Social Sciences. Given that this was the first RDM curriculum established at the McGill Library, we embraced an iterative process and continuously evaluated the workshops and users' feedback. Four additional workshops were added: publishing data with the McGill Dataverse, introduction to the Open Science Framework, yes that's data! Demystifying data in the humanities, and research data management for sensitive data. These workshops are primarily offered synchronously in an online format.

Novice learners

Providing fundamentals training to a group with little to no experience in collecting and organizing their data, while offering easily digestible examples and activities, can help establish a foundation for comprehending RDM at a more detailed level – or for more advanced training. Determining the content of an introduction to RDM was an iterative process. A commonality found among different disciplines revolve around guiding students to understand how data management in their day-to-day activities was subjective to themselves and required them to develop an understanding of how that subjectivity could be confusing to anyone else dealing with their work. This introductory workshop was also purposed for participants to learn easy interventions in organizing their existing work.

This led to the first completed iteration of an introductory workshop, of which the contents focused on concepts of folder hierarchies, file naming, formats, and documentation. The workshop went through an activity for each concept. Activities were meant to highlight that within a room people, how each person had a unique way of deciding how folders were arranged, what was deemed an important subject in file naming, and figuring out someone's method of file naming before looking at their documentation.

Advanced learners

The commonality of RDM issues amongst faculty or research staff gravitated toward issues concerning more detailed aspects of data management. Due to the supervisory roles of faculty and staff, it was unsurprising that they felt their students needed formal training on how to better manage their data regarding their research environment.

Discussion with a variety of faculty and staff became the leading factor in determining the rest of the content for the RDM workshop curriculum. Each point of concern identified became one workshop in our RDM curriculum. Topics included writing data management plans, how to handle sensitive data, storage capacity and organization, and transfer of data once a lab member leaves.

Discipline/Domain-specific

The RDM curriculum was assembled to cover topics generally enough so that anyone interested could attend. However, we understood that some disciplines require unique considerations that would not be easily addressed

in our workshops. In turn, three other workshops were added to the curriculum: RDM for sensitive data, RDM for Medicine and Health Sciences, and RDM for the Humanities. With these workshops, specific examples could be tailored to aid in understanding the nuances of data management in disciplinary domains or special circumstances.

Data regarding marginalized identities/ historically marginalized people

In line with the discipline and domain-specific considerations for sensitive data, a section on understanding and working with Indigenous Data Governance was also added to the workshop. Specifically, workshop attendees are introduced to two sets of principles: CARE (Global Indigenous Data) and OCAP® (Canada-specific First Nations Data).

Together, the CARE principles and OCAP® provide a framework for Indigenous Data Governance that prioritizes Indigenous self-determination and sovereignty and respects the cultural and ethical considerations of Indigenous communities.[18,19] These principles aim to prevent further exploitation and harm to Indigenous peoples and ensure that research and data collection are conducted in a thoughtful and ethical manner.

METHODS

To frame participants' learning, we created learning objectives based on the previously mentioned Frames "Information Creation as a Process" and "Research as Inquiry." You can find a detailed breakdown of the Knowledge Practices and Dispositions used as well as their corresponding learning objectives in Table 1.

TABLE 1

Learning Objectives and Their Accompanying Knowledge Practices and Dispositions

Learning Objectives	Framework Knowledge Practices or Dispositions
• Understand why RDM is important • Describe the research data lifecycle	Articulate the traditional and emerging processes of information creation and dissemination in a particular discipline
• Apply FAIR and CARE principles • Explain the limitations of openness for sensitive data	Follow ethical and legal guidelines in gathering and using information
• Create a file naming convention	Organize information in meaningful ways
• Describe the best practices for storing, sharing, and archiving research data • Identify open licenses relevant for research data	Understand that different methods of information dissemination with different purposes are available for their use

Given the limited amount of time for each workshop, we chose to focus on one learning objective to evaluate learning. Our goal was to focus on measuring proficiency with certain tasks involved in research data management. We selected the Knowledge Practice "Organize information in meaningful ways" which is a part of "Research as Inquiry" to design an activity centered around the learning objective "creating a file naming convention." You can find a description of the activity below. To help us evaluate participants' progress with this learning goal, we created a grading rubric that detailed different levels of proficiency. Rubrics are a "reliable and objective method for analysis and comparison" and have been used consistently by librarians in the past decades to evaluate information literacy.[20]

We broke down the learning objective into four criteria to help us measure users' levels of data literacy: date, name, version information, and formatting of the overall file naming convention. We then established a three-point grading scheme: poor (1), average (2), and excellent (3) with average serving as the basic threshold of understanding for creating a naming convention. For example, for the first criterion, date, we evaluated if users not only included a data but whether it followed an approved standard for dates. If they did not include a date, they

received a grade of 1. If they only included a placeholder for a date or did not follow the best practice for dates, then they received a grade of 2. We established that if they included a date, whether formatted correctly or not, they understood the importance of including this element. If they followed the best practices we presented, then we rated them as having an excellent understanding of this criterion. We used a similar approach to establish the grading of the other criteria. You can consult the grading scheme in table 2 below.

TABLE 2

Grading Rubric: Creating a File Naming Convention

Criteria	Poor (1)	Average (2)	Excellent (3)
Date	No date is included in the naming convention	Some date information, including a placeholder such as [date], is included; it may not follow a machine-readable scheme	A complete date is included in the ISO 8601 machine-readable format (yyyymmdd) or (yyyy-mm-dd)
Name	The file is not given a descriptive name (e.g., no topic or subject). One naming element may be used.	A somewhat descriptive name is used; it could be too generic for unique identification. 2 naming elements are used to identify the file.	A unique and descriptive name is used. At least 3 naming elements are used (excluding date and version)
Version information	No version information is included	Version information is provided but incomplete: the version number or the initials of the contributors could be missing	Complete version information is provided and includes initials for collaborators on the file
Formatting of convention	The convention does not abide by basic formatting rules for files (e.g., includes special characters that are not machine-readable or spaces)	The file convention makes use of some formatting rules. It is not completely machine-readable. Includes a maximum of one element that's not machine-readable such as special characters and spaces.	The file convention abides by formatting rules and uses underscores or hyphens or camelcase where appropriate. The file is machine readable.

This study relies on a pre- and post-test quasi-experimental intervention during introductory RDM workshops. The intervention consists of instruction on best practices related to file naming conventions. Workshop attendees are asked to view a black and white image of a small white dog carrying a slipper. Workshop attendees are given the following instructions: "I just showed you a photo of my dog, Chopin. How would you name this file?" (See Figure 1). Workshop attendees are given 1-2 minutes to respond via PollEverywhere, a cloud-based free polling application, or a McGill University enterprise licensed version of Microsoft Forms.[21] In both cases, the data were collected anonymously, and respondents were asked to keep their browser windows open to preserve the connection between their first and second attempts. Following their first attempt at naming the image file, we review the responses, which typically demonstrate that although all the attendees are viewing the same image with the same information, their proposed file names are highly variable and lack consistency.

In the next part of the workshop, we review best practices related to file naming. Specifically, we discuss the ISO 8601 date format (i.e., YYYY-MM-DD) as an internationally accepted best practice for maximizing interoperability across various systems and software. We also note that for research data, including the initials of the file creator, a project acronym, a topic or subject of the file, and versioning information, are all important elements in uniquely identifying the individual file. We discuss the purpose of following best practices for file naming, including project management for researchers who may not remember the contents of specific files five or ten years into the future. In addition, to improve the reproducibility or re-use of research data, it is necessary for files to have descriptive names so that other researchers may understand or identify the contents without opening the file itself.

FIGURE 1

RDM Workshop File Naming Activity Image

The post-test for this activity involves viewing the same image of Chopin the dog with the following additional instructions: "How would you name the photo according to the information I give you. This photo my of dog Chopin, was taken on August 5th, 2018. It is a polaroid photo. The photo is in black and white and was taken at my parent's home in Toronto, Ontario." At this point, we ask workshop attendees to again submit a potential file name for this image. We have observed over two years that the file names seem to substantially improve following the activity and the discussion of best practices. During this section of the workshop, we discuss the observed differences with workshop participants, noting that although the file names incorporate elements related to best practices and are typically improved in terms of interoperability or machine-readability, there are many unique file names. The overall learning outcome for this activity is for workshop attendees to understand that file naming conventions are important for establishing standardization and ensuring consistency across and within research datasets.

We used manual content analysis to independently code each pre- and post-instruction file name. Content analysis is a method of reviewing qualitative data, such as text, to categorize observations.[22,23,24] Content analysis is an iterative process in which it may be necessary for coders to re-code the data or a sample of the data to calibrate themselves to the categorization criteria. To ensure rigor, at least two coders must independently analyze the data according to a standardized codebook or rubric. To refine and provide examples for the initial rubric, two of the authors coded a sample of pre- and post-test file names. After adding clarifying information to the rubric, the two coders re-coded the same sample to ensure agreement. The three authors each coded two-thirds of the full dataset, meaning that all file names were coded two times independently.[25] Following two rounds of coding, we reached a high level of inter-rater reliability (percent agreement > 90% or $\kappa > .70$) for all items.[26,27,28]

See Table 3 below for inter-rater reliability analysis results.

TABLE 3

Inter-rater reliability analysis results

Variable code/shorthand	Percent Agreement	Cohen's Kappa (κ)
Pre-test Date	94.4%	0.912
Pre-test Name	94.4%	0.919
Pre-test Version	96.3%	0.856
Pre-test Formatting	91.9%	0.865
Post-test Date	91.9%	0.853
Post-test Name	98.8%	0.975
Post-test Version	90.1%	0.844
Post-test Formatting	93.2%	0.882

The inter-rater reliability outcomes, including percent agreement and Cohen's Kappa for each variable, were produced using SPSS, a statistical analysis software program.[29] Following the analysis of inter-rater reliability, two of the authors reconciled all remaining disagreements by re-coding inter-rater discrepancies. In most cases, disagreements arose due to subjective interpretations of phrasing related to the name category of the rubric. For example, we debated whether adjectives or verbs should count as an independent naming element or as part of a single element (e.g., "happy dog," "white dog," etc.). Ultimately, we decided to consistently rate these types of phrases as single naming elements. Overall, there were relatively few disagreements, and those disagreements were the results of consistently applied subjective interpretations that could be reconciled by comparing them against the rubric.

RESULTS

The purpose of this study is to determine whether the file naming instructional activity improves the data literacy of workshop participants. Data literacy in this case is operationalized as proficiency in applying best practices for file naming encompassing four file naming elements. The rubric is designed such that a score of 2 for any element of the file name is the threshold for proficiency, with a 1 corresponding with a lack of proficiency and a 3 corresponding with a high level of proficiency. To determine whether workshop participants gained proficiency in data literacy, we compare the average scores for each attendee pre- and post- the instruction intervention (n = 127 after dropping 34 observations for which either the pre- or post- response was missing. In other words, only complete data encompassing both a pre- and post- response from the same individual are included in this analysis).

The average score of the four file naming elements for the pre-test observations is 1.72 (σ = 0.326), which is below proficiency according to the rubric. The average score of the four file naming elements for the post-test observations is 2.35 (σ = 0.391), which is above the threshold for proficiency according to the rubric. We conducted a one-tailed paired t-test to determine if the difference in means between the pre- and post-test observations is statistically significant. A one-tailed paired t-test is used when comparing means between two normally distributed scores from a set of matched individuals, (i.e., a pre- and post-test score can be matched to each individual participant), where there is an expectation that scores will increase or decrease. The results of the paired t-test showed a statistically significant gain in proficiency (t = 17.243, n = 127, $p < 0.001$). The effect size (Cohen's d) is 1.53, which is high.[30]

DISCUSSION

Consistent with recent literature, we developed an RDM curriculum encompassing several workshops covering a range of topics and domain-specific issues. In addition, there are components of each workshop that are geared toward novices and also components geared toward more advanced practitioners. Although these RDM trainings may be categorized as "one shot" instruction, we have endeavored to create a full training curriculum aligned with the ACRL *Framework*. This study offers both the development of a novel rubric for assessing proficiency of naming files, which we claim is a direct operationalization of information literacy as applied in the context of RDM, and also a statistical analysis of a quasi-experimental approach to establish the effectiveness of a primary active learning component of these "one-shot" RDM training workshops.

The results of this study indicate that our instructional intervention successfully increases the proficiency of RDM workshop attendees with regard to file naming best practices. On average, participants across a range of contexts and disciplines scored below proficiency for naming an image file according to RDM best practices. Following an intervention in which workshop instructors discuss the benefits and justification for using file naming conventions, (e.g., to improve the organization of files and information, to ensure discoverability and interoperability in the future, etc.), in addition to specific standards to implement when naming files (e.g., ISO 8601 for dates), participants are asked to complete a similar exercise, but with additional information about the file. The results of this study demonstrated that the average score for workshop participants following the intervention shifts above the threshold for proficiency. Notably, this shift is statistically significant.

Overall, the results of this study indicate it is worthwhile to develop short and targeted interventions in the context of "one shot" RDM training. In other words, learning outcomes grounded in theoretical principles such as the ACRL *Framework*, when applied to related literacies involving data, may be achieved through practical and applied exercises that demonstrate immediate improvement directly to participants.

CONCLUSION

Navigating complex and inter-connected technological, policy, and legal frameworks regarding research data management (RDM) is presenting an increasing challenge for academic researchers. While graduate students and researchers are well-versed in data analysis and research methods, they are rarely taught best practices for RDM and their implications for grant-funded research. These challenges present new opportunities for RDM outreach and engagement via academic libraries. Functional specialists in RDM are well-positioned to teach research data management practices to researchers and while subject liaison librarians may not be experts on the topic, they are natural partners for these initiatives. This study offers an in-depth analysis of one RDM training instructional intervention developed through a collaboration between an RDM specialist and subject librarians. In order to assess the success of their teaching, they created a pre- and post-test to measure the attendees' understanding of the RDM principles presented in the workshops. Empirical findings of this study indicate that researchers benefit from even a single RDM training session. However, additional research is needed to investigate discipline-specific needs in this context and whether novices are more likely to achieve gains in proficiency compared with advanced participants.

NOTES

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