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Using a Data Management Plan Review Service as a Training Ground for Librarians

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INTRODUCTION Research Data Management (RDM) offers opportunities and challenges at the interface of library support and researcher needs. Libraries are in a position of balancing the capacity to provide support at the point of need while also implementing training for subject liaison librarians grounded in the practical issues and realities facing researchers and their institutions. **DESCRIPTION OF PROGRAM/SERVICE** The North Carolina State University (NCSU) Libraries has deployed a Data Management Plan (DMP) Review service managed by a committee of librarians with diverse experience in data management and domain expertise. By rotating librarians through membership on the committee and by inviting subject liaisons librarians to participate in the DMP Review process, our training ground model aims to develop needed competencies and support researchers through relevant services and partnerships. **AUDIT OF PROGRAM/SERVICE** This article presents an audit of the DMP Review service as a training ground to develop and enhance competencies as identified by the Joint Task Force on Librarians' Competencies in Support of E-Research and Scholarly Communication. **NEXT STEPS AND CONCLUSIONS** The DMP Review service creates opportunities for librarians to learn valuable skills while simultaneously providing a time-sensitive service to researchers. The process of auditing competencies developed by participating in the DMP Review service highlights gaps needed to more fully support RDM and reinforces the capacity of the DMP Review service as a training ground to sustain and iterate learning opportunities for librarians engaged in research support and partnerships.

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INTRODUCTION

Although data management has been a critical skill for both researchers and librarians throughout the history of these professions, the rise of open data practices and funding agency mandates has driven a significant body of new practice around research data (Antell, Foote, Turner, & Shults, 2014). Library support for data management is attractive because it offers an avenue for building collaborative networks, integrating library support into the research process, and supporting open access to research data (Cox & Pinfield, 2014; Heidorn, 2011; Lewis, 2010). While librarians understand the value of their role as a critical partner in data management, there is a “scarcity of practical guidance for developing data services in an academic library” (Coates, 2014, p. 52). This situation has left some librarians facing challenges for finding practical strategies to meet two related goals: developing skills to support data management and rapidly implementing services that support scholars who struggle to interpret and comply with new funding agency requirements for managing and sharing research data and publications. Librarians may intend to offer meaningful support, but, without practical grounding in data management, they “may not currently have this technical knowledge, may lack domain-specific expertise and may also have limited personal experience of research, all of which may make it difficult for them to position themselves as key players in this area” (Cox & Pinfield, 2014, p. 301).

Scholars often seek support with data management with little time to meet a grant proposal deadline, but there may not be a single librarian with the expertise and credibility to meet those needs. How can libraries simultaneously support research in the moment and train subject specialist librarians so that expertise develops across the institution, especially when there may not be room in the budget to hire a full-time data librarian?

Libraries can achieve both of these aims through strategic deployment of a Data Management Plan (DMP) review service complemented by opportunities to share best practices, learn from each other, and form the broad network of research support on campus. Similar to other libraries, librarians at the North Carolina State University (NCSU) Libraries engage in RDM support through membership on a library committee focused on developing services for campus researchers or through participation in the DMP Review service. For the DMP Review service, we invite the subject liaison librarian relevant to each particular DMP draft to participate in the review, even if they are not part of our committee. This approach creates a training ground for librarians to learn from peers with diverse expertise, share information about best practices, and quickly develop hands-on experience through work with actual data management plans. By adopting this training ground model, we aim to develop needed competencies, empower researchers, and demonstrate our role as a valued partner in the research process.

In this article we describe the roles that librarians play in the DMP Review service offered by the NCSU Libraries to the North Carolina State University (NC State) campus community. We describe our team-based approach that aggregates disparate skills from across the libraries and synthesizes them into a review service to quickly and efficiently respond to researchers' demand for support. We examine the impact and outcomes of the DMP Review service as a training mechanism for librarians within the context of a set of competencies needed to support research data management (RDM).

LITERATURE REVIEW

Research data services provide an important opportunity for library engagement (Fearon, Gunia, Lake, Pralle, & Sallans, 2013; Tenopir, Birch, & Allard, 2012), and library-focused research has responded with a growing body of literature on both theory and practice. This literature includes significant discussion about training and skill-building through the use of library review services as well as best practices and core competencies that inform these efforts.

Training for Research Data Management

Education and training for librarians has been identified as necessary for effective support for research data management (Corrall, 2012; Cox & Pinfield, 2014) and more fully described in foundational work done by scholars such as Carlson, Fosmire, Miller, and Nelson (2011) and organizations such as the Association for Research Libraries (Soehner, Steeves, & Ward, 2010).

Library programs for developing skills to support data management have taken a variety of forms, based on diverse institutional culture, available resources, and the needs of researchers. There is no “one-size-fits-all” approach because the “complexity, heterogeneity, and interconnectedness of data-intensive research is simply too great” (Nilsen, 2014, p. 1). Instead, scholars have identified

great diversity in the strategies employed by institutions to address the needs of their researchers. Current strategies range from a decentralized series of data support services in a variety of departments or units to the creation of committees to discuss campus data needs and services along with the creation of centralized data centers to provide that support. The diversity of response reflects the needs and culture of the institutions, which is to be expected. (Soehner, Steeves, & Ward, J., 2010, p. 20)

Scholars such as Raboin, Reznik-Zellen, and Salo (2012) have discussed strategies for training library liaisons, while others such as Cox, Verbaan, and Sen (2014) describe a resource-based model that uses a long-form curriculum to train learners across the library. The role of special libraries (Charbonneau, 2013) and reference librarians (Carlson, 2012) in data management has also been investigated. Regardless of the methods used, data management in libraries is likely to be a “team sport” (Coates, 2014, p. 56) that requires many librarians to collaborate, share expertise, and continue to work to stay abreast of new developments and practices.

One method that has shown particular promise for this ongoing training is the use of a library data management plan (DMP) review service as a training ground for librarians. Raboin, Reznik-Zellen, and Salo (2012), for example, highlight efforts such as Tufts University’s Data Management Services Team and the Data Working Group at the University of Massachusetts Amherst, both of which offer consultative services for data management planning that also build and enhance library expertise.

Similarly, Johnston, Lafferty, and Petsan (2012) describe their success with a data management planning workshop at the University of Minnesota Libraries that incorporated their grant writing DMP review service. The workshop provided “a wealth of knowledge” that empowered librarians “to better understand researchers’ needs and, in turn, offer solutions and advice . . .” (p. 85). Other scholars make it clear that effective learning is often grounded in “practical hands-on activities, often engaging with real documents such as institutional RDM policies or existing data management plans” (Cox, Verbaan, & Sen, 2014, p. 18).

The New England Collaborative Data Management Curriculum (NECDMC) has been identified as a particularly promising—if resource-intensive—model for training. Designed as a “flexible tool that librarians can easily customize to meet the research data management learning needs of their particular audiences” (Kafel, Creamer, & Martin, 2014, p. 61), the NECDMC offers a series of modules that include targeted readings, lab notes, and review of data management plans. It has been offered in a variety of institutions (Ishida, 2014; Peters & Vaughn, 2014) across North America and to a variety of audiences. Although many participants have praised the flexible and thorough framework, they also note challenges, including the significant amount of time needed to create local content and sizeable investment of time required of all participants (Ishida, 2014, p. 84). Despite these challenges that make out-of-the-box use unlikely, the NECDMC is still praised for its “attempt to standardize instruction around the unwieldy topic of research data management” (Peters & Vaughn, 2014, p. 98).

Core Competencies for Research Data Management

Regardless of the method of training employed, a consistent set of core competencies is beginning to emerge for library support of research data. These core competencies can be used to audit a DMP Review service's effectiveness as a tool to build and enhance those core competencies.

Different groups have presented competencies that could be used to gauge the effectiveness of library support for research data management or to build a program supporting data management. Raboin, Reznik-Zellen, and Salo (2012) describe shared competencies across three surveyed libraries that include “garnering institutional support, managing the integration of services with new or existing staff structures, and continuing to meet researchers’ needs as they evolve” (p. 145). Similarly, Zilinski, Chan-Park, Dasler, and Nicholls (2013) present commonalities across services at Purdue, Baylor, Maryland, and Michigan. In contrast, Creamer, Morales, Crespo, Kafel, and Martin (2012) identify twenty “needed competencies” for health science librarians that they group into two large categories: “data literacy” and “technical competencies” (p. 24). Cox, Verbaan, and Sen (2012) examine the extent to which existing librarian roles align with competencies needed to support research data management.

In addition to identifying and describing competencies, these articles express the value of technical and non-technical competencies such as marshalling institutional support, data literacy, intellectual property, and the ability to continue to be flexible as researchers’ needs evolve. There is also a rich literature on data curation as a core competency for e-science librarians (Carlson, et al., 2011; Kim, Warga, & Moen, 2012; Stanton, et al., 2011; Tenopir, Sandusky, Allard, & Birch, 2014).

Significant work has been done by Whitmire (2014) and others (Whitmire, et al., 2015) reviewing DMPs to expose the common practices and hurdles faced by scholars in order to provide insight into the detailed individual data management habits of scholars. This work builds on research done by Mischo, Schlembach, and O’Donnell (2014) and Parham and Doty (2012). Funded by an IMLS grant, this work has generated an analytic rubric “to standardize the review of data management plans as a means to inform targeted expansion or development of research data services at academic libraries” (DART Project, 2015).

The Joint Task Force on Librarians’ Competencies in Support of E-Research and Scholarly Communication (2014) provides a useful synthesis of these competencies that can be used to audit a DMP review program. This collaboration is the result of work conducted by the Association of Research Libraries (ARL), the Canadian Association of Research

Libraries (CARL), the Association of European Research Libraries (LIBER), and the Confederation of Open Access Repositories (COAR). This work identifies three broad areas with corresponding competencies: “providing access” through repositories, copyright negotiations, and digital tools; “advocacy and support,” tied to funder mandates, DMPs, and research practice; and “managing data collections” with metadata standards, discovery tools, and storage infrastructure (Joint Task Force, 2014, p. 2).

DESCRIPTION OF PROGRAM/SERVICE

The NCSU Libraries’ DMP review service is designed to be team-based, light, and nimble (Cross & Davis, 2014). We recognized that reviewing DMP drafts would “require the expertise and resources of teams spanning many disciplines” (Coates, 2014, p. 52). Because we do not have a full-time research data librarian or a campus-wide data repository, we gathered experts from across the Libraries who could work together to share knowledge and creative solutions as members of our Research Data Committee (RDC). The RDC serves two primary roles: (1) to develop and implement training for librarians and researchers and (2) provide services at the moment of need to support RDM for our university. These interrelated roles consistently reinforce one another. Skills gained from the DMP review process provide hands-on training for librarians, while the Committee’s shared expertise facilitates immediate support for researchers on a deadline.

The Committee as Cornerstone for Data Management Support

We were deliberate about strategically selecting librarians to serve on the RDC who brought expertise to meet the needs of researchers managing their data. Informed by the elements in a data management plan and the strengths of the NCSU Libraries, we included librarians with expertise in copyright and licensing, digital scholarship, grant funding, and the grant review process. Members also included librarians with expertise in geospatial and numerical data, as well as digital humanities and open scholarship, and a rotation of subject liaison librarians who bring diversity of expertise across multiple disciplines. This gave us a core team that was prepared to assess technical specifications, legal challenges, compliance with funding expectations, and often discipline-specific norms.

After a year of collaboration, we began to rotate new members into the RDC, sending trained librarians back into the field and bringing in new members for on-the-job training in data management and data sharing. Rotating members in and out of the RDC has continued to expand our network with stakeholders across campus and created new relationships to build upon.

Armed with these diverse skills for the core team, the RDC iteratively developed both internal (for librarians and library staff) and external (for researchers and their support networks) workshops, presentations, and a data management plan (DMP) review service as part of our growing portfolio. The committee acts as a point of contact, a collection of relevant expertise, and a hub that connects researchers with campus and national resources. Whether a researcher needs guidance locating a subject-specific data repository like Dryad or best practices for securing data related to their patentable research being commercialized through our Office of Technology Transfer, the RDC is a hub for managing research data.

DMP Review as Training Ground

In addition to the diverse support offered by this team-based approach, we have seen significant benefits in training all members of the RDC in skills related to data management as well as discipline-specific practices. As one librarian reported, “one thing I’ve learned from being on the committee is how other librarians at NCSU interact with researchers in their subject areas and the kind of knowledge they need to have about things like funding agencies and University guidelines.” To scale out awareness and knowledge, RDC members have offered workshops for others in the Libraries on institutional review board protocols, directives for public access to federally-funded research, reviewing DMPs, data rights and ownership, and data management for students. Leveraging what we learned through deploying RDM support for campus, these workshops have facilitated rich, engaging training opportunities grounded in actual issues faced by researchers.

The literature consistently emphasizes the importance of using practical hands-on activities (Creamer, et al., 2012, p. 21) such as working with institutional RDM policies and data management plans (Cox, Verbaan, & Sen, 2014, p. 18). For this reason, the NCSU Libraries’ training ground model uses actual DMP documents to familiarize librarians with the primary issues facing researchers.

Because our team is made up of librarians with expertise in specific aspects of data management, we are able to use the collaborative evaluation of plans to share and develop knowledge with each other. Shortcomings in one area of a DMP are identified by the individual expert, who models analysis, demonstrates tools, and drafts language responding to the shortcomings. Others on the committee are exposed to the expert analysis, made aware of the tools, and given model language they can use going forward. The process has iterated across numerous DMP documents, highlighting variations on common themes and allowing committee members to experiment with responses, guided by the more experienced members as needed.

Because no member has deep expertise in all aspects of a DMP, each committee member serves as both an expert/trainer and student/trainee on a given DMP document. This creates a supportive environment that helps individual librarians gain expertise in general data management practice as well as technical topics including Creative Commons licensing, metadata standards, and discipline-specific repositories. It has also modeled best practice for drafting responses that are manageable and useful for researchers who may be overwhelmed by feedback that is too detailed or technical. As one librarian on the Committee commented: “I’ve learned how to write a response that focuses on the bigger problems with the DMP, rather than giving a laundry list containing both large and small problems.” In short, the committee and the DMP Review service have not only galvanized the development of a suite of expert services, but also established a training ground for librarians engaged in research support.

AUDIT OF DMP REVIEW SERVICE AS TRAINING GROUND

Data management support represents a nascent area for libraries, with many services in the planning or early-adoption stage. Libraries need more opportunities to develop competencies as described in the March 2014 draft of the Joint Task Force on Librarians’ Competencies in Support of E-Research and Scholarly Communication. Concomitant with these opportunities, libraries need a gauge to help determine the effectiveness of our strategies and actions. As a first step toward developing a robust set of assessment measures, we use the competencies identified by Joint Task Force (2014) to audit the capacity of the training ground model employed by the NCSU Libraries to develop librarians’ skills and support for research data management. This audit highlights the opportunities and challenges of using this training ground model to develop and reinforce competencies needed to support RDM.

Providing access to data: This category of responsibilities specifies that librarians have knowledge, expertise, and awareness of data centers, repositories, and data collections. Further, librarians should understand how these data are organized and structured and be aware of methods for licensing access to data while adhering to intellectual property policies. Additional specifications this role includes are awareness and application of tools and methods to support data manipulation and/or analysis including data citation/referencing. These competencies are aligned with the relevant experiences gained through the DMP Review service as a training ground in Table 1 (following page).

In the context of our model, experience in identifying datasets and using discovery tools such as re3data.org (re3data.org, n.d.) and the Data Citation Index (part of the Web of Science™) has mostly been derived from guiding researchers toward relevant data repositories. In our

Providing access to data	
Core competencies	Relevant experience gained through Training Ground model
Identifying datasets, discovery tools	Use tools such as Re3data.org and the Data Citation Index to identify datasets and repositories for data deposit
Data centers, repositories and collections	Work with data repositories to identify eligibility and criteria for data deposit; investigate how data is organized in repositories; exposure to emerging standards for data citation
Data organization and structure within these collections	
Data citation/referencing	
Data licensing and intellectual property policies and principles	Exposure to licensing language and terms for using external datasets; developed knowledge of licensing options to support sharing and reuse of data
Data manipulation/analysis techniques and tools	Expertise limited to a few librarians with specific geospatial and data analysis skills

Table 1. Librarian competencies for the role of providing access to data and corresponding experience gained through the “training ground” model.

experience, researchers who seek guidance on their DMP drafts are planning on generating their own data or have already identified external datasets for their projects. When researchers plan to use external data in their research, we have been exposed to legal language and terms of art related to licensing data resources with the guidance of the scholarly communication librarian on our team. In other cases, we learned to identify appropriate licenses and data citation standards to enable re-use of the data with the goal of ensuring that our researchers have the ability to share the external data as part of the public sharing mandate of funding agencies.

In cases where researchers plan to integrate or augment external data with data they generate themselves, we have a role in helping them ensure that the methods by which the external

data were manipulated and analyzed are consistent with those they use to generate their own data. Even if a researcher is only using external data, it is important to document the methods used to generate and analyze that data.

A few librarians at the NCSU Libraries have developed robust skills in data analysis (e.g., one librarian is certified in SAS programming and another has significant experience with geospatial data). In order to play a more active partnering role with researchers to learn and develop data manipulation and analysis techniques, we recognize that we need to broaden this skillset across more librarians.

Advocacy and support for managing data: This category of responsibilities specifies that librarians have knowledge, expertise, and awareness of data management plans, research practices and workflows, funding agency policies and requirements with respect to data management and sharing, and sufficient knowledge about data repositories to support data management. Further specifications include knowledge about the benefits of sharing data and re-use of data. This involves unpacking options for sharing data, understanding open access, navigating intellectual property rights, licensing of data collections, and adhering to publication requirements of journals. These competencies are aligned with the relevant experiences gained through the DMP Review service as a training ground in Table 2 (following page).

The process of reviewing a DMP draft often requires helping researchers understand what a plan needs to address and why defining a plan for data management is critical for research integrity, sharing, and reproducibility. By reviewing DMP drafts, we have been exposed to a wide range of practices and have become attuned to the necessary and sometimes variable components of DMPs across funding agencies, especially those from the NIH and multiple directorates and divisions within the NSF. Our training has also been augmented by discussion of example data management plans that include successful and unsuccessful language as well as model text from several sources. Working with these documents has helped train us in best practices for writing, as well as structuring, DMPs.

A primary component of our DMP Review service includes providing guidance about appropriate data repositories, especially since our own institution does not support a dedicated data repository for all research data. The DMP Review service has provided a practical context for us to learn about data repositories across multiple disciplines and leverage inventories of data repositories (e.g., re3data.org). In some cases, we have contacted disciplinary data repositories on behalf of researchers to identify eligibility requirements and criteria needed to contribute data. In addition to supporting our researchers, gathering this information helps familiarize us with expected practices for data deposit into individual repositories.

Advocacy and support for managing data	
Core competencies	<i>Relevant experience gained through Training Ground model</i>
Funders' policies and requirements	Exposure to wide range of funding agency requirements for DMPs
Data management plans	Understanding of the main elements of DMPs with exposure to both successful and unsuccessful examples across multiple disciplines; awareness of researchers' practices and literacy regarding best practices for managing data
Research practices and workflows	
Data centers, repositories and collections for deposit	Work with data repositories to identify eligibility and criteria for data deposit; investigate how data is organized in repositories; exposure to emerging standards for data citation
Articulate benefits of data sharing and re-use	Learn about methods to help researchers effectively share their data and publications while maximizing their intellectual property rights
Data sharing options, open access, IPR, licenses	
Disciplinary norms and standards for data management	Exposure to practices that span use of commercial grade cloud storage to storage on local media; learn about benefits that established repositories provide (e.g., persistent identifiers, protection of sensitive data, citation tracking, preservation services)
Data structures, types and formats	Learn ways to standardize file-naming, migrate to non-proprietary file formats, document and describe data structure through metadata
Best practices for managing data, standards, metadata and vocabularies	Learn about variation in metadata standards; in many cases, standards do not exist and we offer to assist in creating standard practice for research projects
Data publication requirements of specific journals	Learn about specific data sharing expectation of journals that require data publication; likewise, learn about terms in publishers' author agreements that may limit researchers' ability to meet sharing funders' public access mandates
Data audit (i.e., identify range of datasets on campus) and assessment tools (e.g., Data Curation Profiles)	Limited experience in identifying datasets in campus and in employing assessment tools

Table 2. Librarian competencies for the role of advocacy and support for managing data and corresponding experience gained through the training ground model.

A locally relevant outcome of the DMP Review service is that it has taught us about limitations in our campus data storage infrastructure. By working with researchers to find solutions for data storage, we have a better sense of the impact that lacking a campus data repository presents. For example, a researcher in Horticultural Sciences, applying for an NSF grant needed to share data and instrument calibration metadata. There is no discipline-based repository available for her research data, and, since she lacks adequate support for creating and maintaining a website, she plans on making the data available only upon direct request to her. The main liabilities with this plan are that it does not support long-term preservation, and this mode of sharing is unlikely to suffice for NSF potentially putting funding for her research at risk. Having first-hand knowledge of these limitations and liabilities puts us in a position to advocate for better data infrastructure on our campus.

Reviewing DMPs provided the context in which we have learned about Creative Commons and Open Data Commons licenses for datasets to ensure that others give appropriate attribution and adhere to researchers' expectations for re-using their data. By learning about and presenting multiple options to researchers for complying with mandates, we have developed a role whereby we help researchers share their work while also maximizing credit for their work.

It is not uncommon for researchers to plan on sharing data via services such as Dropbox or by direct request to the researcher. By reviewing DMP drafts, we have learned about the drawbacks of commercial cloud storage (e.g., Dropbox, Google Drive) and about the benefits of an established data repository. These benefits represent many of the disciplinary norms and standards for data management including assignment of persistent identifiers for datasets to aid in sharing and citation, support in protecting data derived from human subjects, and, in some cases, tracking of citations to datasets to help monitor the impact of data within the research community.

Each new DMP draft that we receive is an opportunity to learn about the variation in disciplinary norms for data sharing—in some disciplines such as genetics, sharing is an accepted and expected practice, and in others, such as chemistry, data sharing is a generally unfamiliar practice. In reviewing DMP drafts, we have learned about the types of data that should be shared (including software and code) versus the types that are not expected to be shared such as preliminary analyses and trade secrets. Our team-based approach is particularly powerful here since we can rely on the discipline-specific experience of individual members who understand best practice in their particular domain.

By reviewing DMP drafts, we have learned about the necessity of documenting strategies for processing data and standardizing file-naming practices to ensure both version control and

quality control. When working with researchers, we investigate the availability of standard metadata schema for particular disciplines to ensure that datasets have adequate metadata to enable full discovery on the web as well as potential re-use or replication. The opportunity to work more closely with researchers to learn how to develop metadata schema (or data dictionaries) for disciplines that lack appropriate standards represents a significant growth area for us.

We have learned about varying expectations for how data should be shared for specific journals that require data to be made available alongside publications. In some cases, publishers have stipulated specific data repositories be used and, in other cases, are less prescriptive. We have also been exposed to problems that researchers face when they sign publishers' author agreements that may limit their rights to manage and share their data and, therefore, also limit their ability to comply with funder public access mandates. We benefit from an existing support system for reviewing publication agreements and the ability to leverage relationships with publishers. This bore out in an undertaking by several librarians to aid NC State's NIH-funded researchers to meet the NIH Public Access compliance mandate by addressing compliance issues with both publishers and authors for over 1000 publications. Through shared problem-solving, the expertise of particular members cascades across the RDC; everyone becomes more confident discussing agreements, reaching out to publishers, and helping researchers succeed in compliance.

At this stage, we have not engaged in a comprehensive data audit to identify the range of datasets that exist across disciplines at our institution. This represents a growth area for us if our campus administration decides to pursue a full-scale data inventory to identify research data assets.

Managing data collections: This category of responsibilities specifies that librarians have knowledge, expertise, and awareness of the application of metadata standards and best practices including domain ontologies and the use of identifiers. Further specifications include techniques for selection and appraisal of datasets, the application of discovery tools, database design, data integration and linking, storage infrastructures, preservation metadata, and digital forensics for curation. These competencies are aligned with the relevant experiences gained through the DMP Review service as a training ground in Table 3 (following page).

As previously discussed, we have had opportunities to learn about disciplinary standard metadata schema, but have gaps in our skillset in terms of direct development of standard schema where none exists.

Managing data collections	
Core Competencies	<i>Relevant experience gained through Training Ground model</i>
Metadata standards and schemas, data formats, domain ontologies, data citation, data licensing; identifiers	Learn about variation in metadata standards; offer to assist in creating metadata schema standard for research projects; exposure to emerging standards for data citation; developed knowledge of licensing options to support sharing and reuse of data; learn about document and author identifiers (e.g., ORCID, ResearcherID, EZID DOI minting)
Selection and appraisal techniques for datasets	Limited experience in selection and appraisal since we do not have a campus data repository
Discovery tools	Some experience in these areas when providing support for researchers in identifying disciplinary or generic data repositories for data deposit; expertise in a few librarians who manage locally curated special collections and university archives
Database design types and structures	
Data linking and data integration techniques	
Data storage infrastructures	
Digital preservation metadata	
Forensic procedures in digital curation	

Table 3. Librarian competencies for the role of managing data collections and corresponding experience gained through the “training ground” model.

We have held internal (for librarians) and external (for researchers) workshops to learn about the use of document and author identifiers in the context of supporting the creation of biosketches in SciENcv (a researcher profile platform gaining adoption by federal funding agencies including NIH and NSF). Through these workshops, we have been exposed to the value of identifiers such as ORCID, ResearcherID, and the EZID DOI minting service so that we can be better-informed, more articulate, and ultimately make a more compelling

case for campus adoption. This training has led to targeted conversations with researchers, but campus-wide adoption will need buy-in from multiple stakeholder groups and a more robust research data infrastructure.

Because we do not have a data repository, most of us (subject liaison librarians in particular) have not developed competencies in selecting and appraising datasets for local storage in the context of RDM support. This is an opportunity area for us to pursue appropriate training and experience, especially if our institution implements a campus-wide data repository. Guidance about discovery tools, data integration, storage infrastructure, preservation metadata, and digital forensics tends to be concentrated in curation of special collections and university archives and less so in broad-based support for research data. Since we do not have a campus-wide data repository, much of what we learn through the DMP Review service is centered on how to ensure safe and secure storage and backup for digital files.

NEXT STEPS AND CONCLUSION

The primary objectives for providing the DMP Review service at NC State is to help our researchers be more competitive in the research proposal process and to make research data assets more widely available. By equipping librarians with the competencies and confidence to support researchers' data management needs through practical skill-building encounters such as the DMP Review service, we have been able to provide necessary services at the point of need.

A critical outcome of offering this service has also been to provide training for our librarians on providing RDM support for our campus research community. Auditing our DMP Review service as a training ground for developing and enhancing competencies for supporting research data management helps us reinforce our efforts and identify gaps that exist in our collective and individual skillsets and knowledge. Insights gained from this audit can be applied to other libraries with emerging or established RDM services and corresponding librarian training needs.

Addressing Gaps

In the course of reviewing DMP drafts, we have encountered various gaps in our knowledge and expertise that are being met by other units on campus. To address these gaps in our knowledge, we have expanded our network of established relationships with research administrators at the college and department level as well as with groups such as the proposal development unit, institutional review board, campus information technology, technology transfer group, and statistical consulting unit.

The DMP Review service has also given us the credibility and experience to advocate on behalf of researchers and provide informed input for campus-wide RDM strategies. Our first efforts to advocate for campus support for data management centered on storage issues. Based on our work supporting researchers' with their data management plans, we identified a significant gap for researchers looking to store small and medium-sized datasets. While researchers with big data projects could tap into an established national infrastructure for storage, the absence of campus resources for researchers with smaller datasets and no natural disciplinary-specific repositories left them to find their own solutions.

In response to this challenge, our committee drafted a research data curation report illustrating the issues using examples from the DMP Review service. The report, which targeted campus IT leaders, led to increased discussion of the issue and attention from campus administration. Our campus is now in the early stages of developing more robust support for research data storage.

To help address competency gaps in storage infrastructure, preservation metadata, and digital forensics, we are harnessing expertise from the NCSU Libraries' special collections digital program and archiving unit. Working with colleagues in our library consortium and with data science leaders in our region, we are developing custom training opportunities for the NCSU Libraries to develop competencies amongst all of our subject liaison librarians in the areas of data manipulation and analysis, data integration, and storage infrastructure.

Sustaining the Committee to Develop Awareness, Knowledge and Expertise

Our team-based approach has enabled us to be light-weight and nimble as we explore and implement sustainable services around the needs of research data management. Using the DMP Review service as platform whereby we iteratively develop and scale out awareness, knowledge, and expertise, we have been able to learn more about RDM across multiple disciplines.

We will continue to strategically rotate librarians through the Research Data Committee with the intention to support research data management across more domains. This rotation also aids in filling competency gaps for supporting for data management as well as tapping expertise in disciplinary metadata standards and domain ontologies.

Moving Beyond RDM Support to Partnering in the Research Process

By offering the DMP Review service, we have created opportunities to engage with researchers in the grant proposal process. However, we could engage more deeply in the research process

and go beyond consulting on data management plans. In order to do so, the service must earn the recognition and respect of researchers as a source of valuable expertise. Committee members must also develop fluency with the “social world of organisations, projects, thought-leaders and key influencers, technologies, discourses, concepts and terminology that have to be mastered in order to be ‘taken seriously’” (Cox & Pinfield, 2014, p. 300-301). Similar to the model developed by Purdue University Libraries (Garritano & Carlson, 2009), we intend to test and explore a model of embedding librarians as grant-funded senior personnel to lead data management practices for specific research projects.

Our first foray into this model involves one of our engineering research librarians who is being written into a grant proposal as senior personnel to provide oversight for a materials science research project. The invitation to include a librarian as a key member reflects researchers’ trust in the library as a partner and the expertise demonstrated by the RDC members. Indeed, the language of the proposal singles out the librarian’s “expertise” which puts her in the unique position to define new best practices for data management among interdisciplinary efforts.

In light of the partnership, this project represents an opportunity to pilot an expanded role as a valued partner. The proposal outlines a substantial role for the librarian, who would supervise an NSF-funded position and be responsible for leading efforts to record, organize, and store experimental data.

Using the competencies outlined by the Joint Task Force on Librarians’ Competencies in Support of E-Research and Scholarly Communication (2014) and others in the field, we can be strategic in addressing gaps in core competencies. Conducting the audit has demonstrated to us that we have been effective at helping librarians develop skills to support researchers in data management strategies at the grant proposal stage. Our model of using a DMP Review service to both support research data management needs on campus and to provide a training ground for librarians to learn and practice supporting RDM is extensible to many library environments.

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