Data Information Literacy

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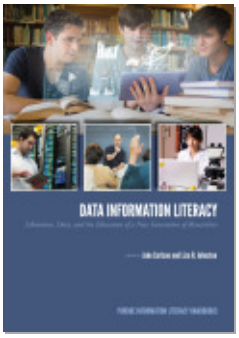

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CHAPTER 2

DEVELOPING THE DATA INFORMATION LITERACY PROJECT

Approach and Methodology

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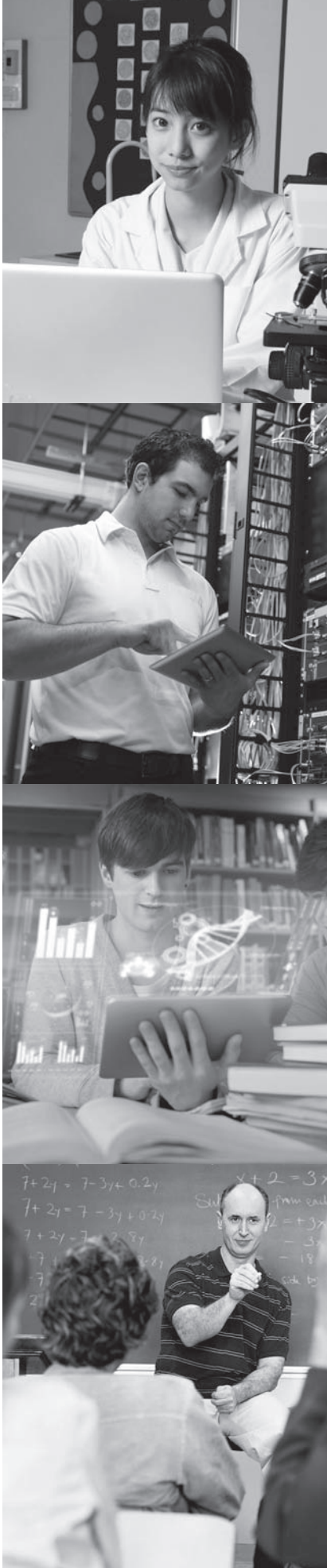

INTRODUCTION

In Chapter 1 we described the foundational research that generated an early articulation of data information literacy (DIL) and the resulting 12 DIL competencies. The next step was to explore how our conceptions of DIL could be applied in practice. To do this we developed a 3-year Institute of Museum and Library Services (IMLS)–funded study to further the DIL concept and to create and implement educational programs for graduate students in science, technology, engineering, and mathematics (STEM). The purpose of the project was to answer two overarching questions. First, what data management and curation skills are needed by future scientists to fulfill their professional responsibilities and take advantage of collaborative research opportunities in data-driven research environments? Second, how can academic librarians apply their expertise in information retrieval, organization, dissemination, and preservation to teaching these skills? This chapter explains the methods and approaches that we used in the Data Information Literacy project.

KEY ASSUMPTIONS OF THE DATA INFORMATION LITERACY PROJECT

Before describing the methodology of the DIL project in detail, we must begin by listing our key assumptions for this project. These assumptions served as our guiding principles in developing and carrying out our work. They are that (a) information literacy is a foundation for DIL; (b) graduate students are a receptive audience for DIL programs; (c) librarians are in a prime position to teach DIL skills; (d) the need for DIL programs has not been fully documented; and finally, (e) to meet this need successfully, librarians must align with disciplinary cultures and local practices.

Information Literacy as a Foundation for Data Information Literacy

One of the key assumptions that we made in developing the DIL project was that we should take advantage of librarians' experiences and long, well-documented history with information literacy (Rader, 2002). We deliberately named our project "Data Information Literacy" rather than simply "Data Literacy" for two reasons. First, we wanted to recognize that the library and education communities have invested a great deal of time and energy in understanding how students learn to acquire, evaluate, and use information; this investment was certainly relevant in exploring how students develop, manage, and curate research data. Information literacy has a long history of exploring, assessing, and transforming instructional models and strategies to ensure their relevancy to particular situations and environments. Explorations in information literacy have been conducted at a broad scale to make sure the frameworks are in sync with the aims of higher education (Pausch & Popp, 2000) or to align with advances in technologies, societal norms, and learning theories (Martin, 2013). Others are more tightly focused on particular models such as embedded librarianship (Kvenild & Calkins, 2011) or offering instruction in an online environment (Hahn, 2012). Data as a type of information have distinctions and idiosyncrasies that merit special consideration, but we believed the information literacy field could provide a solid foundation for our work.

Second, DIL is an area in which librarians can make important contributions. However, teaching students information literacy

competencies in relation to working with research data may seem daunting to many librarians. By directly connecting work with data to a familiar and accepted area (e.g., information literacy), we hope to encourage more librarians to take action to develop DIL programs of their own. We believe that DIL is a logical outgrowth of information literacy and therefore expanding the scope of information literacy to include data management and curation is a logical extension of information literacy concepts.

There are a number of other initiatives that affirm our approach to linking data and information literacy. The Society of College, National and University Libraries (SCONUL) Seven Pillars of Information Literacy model (SCONUL Working Group on Information Literacy, 2011), and the Researcher Development Framework by Vitae (2014), a UK-based nonprofit organization, each incorporate data management skills into their definitions of information literacy and support holistic approaches to helping doctoral candidates acquire skills and knowledge in data management. A report from the Research Information Network (Goldstein, 2011) argued that a broader interpretation of information literacy is needed—one that recognizes research data as information—to ensure that students gain the skills they will need to be successful in their careers. The 2012 LIBER working group on e-science selected research data as a critical area for involvement by libraries in e-science support and recommended that libraries assist faculty with the integration of data management into the curriculum (Christensen-Dalsgaard et al., 2012).

Graduate Students as a Receptive Audience

Another key assumption was the immediate benefit that graduate-level students may gain from building their skill sets in DIL concepts. For example, in the STEM disciplines, graduate students carry out the data management tasks for their own research, and frequently participate in data activities to support lab/team projects as well (Akmon, Zimmerman, Daniels, & Hedstrom, 2011; Westra, 2010). But Gabridge (2009, p. 17) observed that graduate students composed "a constantly revolving community of students who arrive with . . . uneven skills in data management."

Graduate students participate in varying levels of mentoring or apprenticeship. However, research data skill and competency development focuses on more traditional skills such as research design, equipment use, data analysis, and problem solving in the laboratory or field setting rather than those addressed by the DIL competencies (Feldman, Divoll, & Rogan-Klyve, 2013; Leon-Beck & Dodick, 2012). Furthermore, the process through which novice researchers acquire these skills may be influenced by social and cultural factors in their research teams or communities of practice (Feldman et al., 2013). Therefore, acquisition of DIL competencies by graduate students appears to be uneven at best.

When thinking about target audiences for DIL training, it is essential to evaluate the local landscape. Researchers appreciate training that has an immediate impact on their particular disciplinary setting; training which lacks this will be ignored by graduate students (Molloy & Snow, 2012). Interviews, surveys, and post-training feedback can help libraries confirm the types of research services which may be of interest and beneficial to graduate students and research faculty (Bresnahan & Johnson, 2013; Johnson, Butler, & Johnston, 2012). Finding the best approach to target graduate students with training was a major component of the DIL project.

Knowing that graduate students were a prime audience, the next question was: How and when could we engage this audience? There are a number of pathways by which training can be provided to future scientists. For example, graduate students may be introduced to basic data management concepts via a data management module in "responsible conduct of research" training (Frugoli, Etgen, & Kuhar, 2010). This may lead to other consultations and training opportunities. Institutions are also embedding training in other required courses and programs. While it is important to provide early training (Molloy & Snow, 2012), significant gains may be achieved by engaging students when they are grappling with issues in their own practices (Scott, Boardman, Reed, & Cox, 2013). Most students are interested in training with a strong component of immediacy and practical application (Byatt, Scott, Beale, Cox, & White, 2013; Parsons, 2013).

Librarians Are in an Excellent Position to Teach Data Information Literacy Skills

Librarians are in a unique position to teach DIL in academic environments. Graduate-level courses with a librarian embedded within them have been linked to improved student learning (Kumar & Edwards, 2013; Kumar, Wu, & Reynolds, 2014), and informationists have been successful in deploying services to graduate students and research teams (Hoffmann & Wallace, 2013; Polger, 2010). However, surveys conducted on data management show that very few students consult with a librarian on research data management (RDM) issues (Doucette & Fyfe, 2013). A Research Information Network (RIN) initiative applied the SCONUL Seven Pillars model of information literacy and Vitae's Research Development Framework to the development of data management skills in postgraduate courses in the United Kingdom. The results demonstrated that a wide range of disciplines need data management skills and that core skills as well as discipline-specific training should be embedded into the postgraduate curricula (Goldstein, 2010). These findings indicate an opportunity for librarians to engage graduate students about the issues they face in working with research data.

Demand for Data Information Literacy Programs Needs Further Exploration

The approaches to teaching data management and curation for graduate students in the sciences are either stand-alone courses or programs or one-shot workshops. The stand-alone course approach has been used by several schools of information science, including Syracuse University (Qin & D'Ignazio, 2010), the University of Michigan (n.d.), and the Rensselaer Polytechnic Institute. Syracuse designed a course to teach science data literacy, defined as "the ability to understand, use, and manage science data" (Qin & D'Ignazio, 2010, p. 3), with a focus on preparing students for employment in science or as data management professionals. The University of Michigan developed a research fellowship program, Open Data, centered on building a community of practice around managing, sharing, and reusing scientific data. The curriculum includes a core course on data curation and elective courses from multiple disciplines. The Tetherless World Constellation (n.d.) research center at Rensselaer Polytechnic Institute offers a course in "data science" for graduate students that includes metadata, discovery, workflow management, data analysis, and data mining. One advantage of the stand-alone approach to teaching data skills is the depth of coverage. However, it may be difficult for students to

commit to a course, especially if the course is outside of their discipline.

Becoming prevalent at academic institutions, "one-shot" workshops represent a second approach to data management and curation education. Many of these workshops, such as those offered by MIT (Graham, McNeill, & Stout, 2011) and the University of Minnesota (Johnston, Lafferty, & Petsan, 2012), help faculty and graduate students address requirements for data management plans by funding agencies. Other workshops cover data management as one component of a broader training in research ethics or responsible conduct of research, as required by the National Science Foundation and the National Institutes of Health (Coulehan & Wells, 2006; Frugoli et al., 2010). Workshops require less of a time commitment and are likely to reach more people, but they cannot provide as much breadth or depth.

As the need for students who are capable of managing and curating data sets continues to expand, we are seeing the development of alternative methods. In some cases, online and print materials provide guidance on core data management practices. For instance, the Australian National University created a Data Management Manual that is now in its eighth edition. The university's Information Literacy Program uses this manual as a resource for teaching graduate students (Australian National University, 2013). Other programs have taken a multi-tier approach, providing seminars, lectures, and workshops; integrating data management into research professional development courses; and incorporating discipline-specific content for particular audiences (Byatt et al., 2013).

The DIL project was a means for exploring the strengths and weaknesses of different approaches in educating students about the data concepts they would need to be successful in their careers. We explored a number of possibilities for developing and delivering effective educational programs. Similarly, we recognized that DIL programs would be shaped by educational objectives and constraints due to time, circumstances, and resources. Comparing multiple approaches to developing and implementing DIL programs helps with identifying common themes and differences across approaches.

Alignment With Disciplinary Cultures and Local Practices

Perhaps our most important assumption in developing and implementing the DIL project was that its success depended on our ability to understand and align with existing cultures of practice. We recognized that a DIL education program would cause the students to change the processes and workflows that they had learned previously. This deviation could potentially affect others who depended on the students' work. We wanted to ensure that the DIL project would have a positive effect, not just for the students, but for the faculty and others in the lab. We needed to understand not only the current practices of the students but also faculty perceptions and reactions to the 12 DIL competencies that we had developed. If the faculty or the students saw little value in a particular competency then there was no point in including it in a DIL program (at least initially).

In addition to local practices, we needed to incorporate the perspectives and resources of the disciplines. Each of the disciplines with which we worked had articulated its own set of values, beliefs, and practices with regard to working with research data. Our DIL programs had to be informed by these disciplinary concepts to have the desired impact.

The need to take context into consideration in developing educational programming has received attention in information literacy research. Librarians have largely embraced information literacy as one of their core missions; however, Lloyd and Williamson (2008) argued that conceptions of information literacy that have come out of the library and information science fields are too narrow. Recognizing information skills as a part of sociocultural practices within broader contexts enables practitioners to better understand how people engage with information in ways that are meaningful to them (Lloyd, 2010). Hoyer (2011) also argued for moving away from a generic skills-based conception of information literacy and toward a framework that goes beyond the academic sector into the workplace and other arenas. As the social interactions and relationships within the workplace are factors in how information is accessed, evaluated, and used in workplace environments, social context ought to be accounted for in how information literacy is taught to students.

The idea that curation specialists need to understand the nuances and disciplinary practices of the research communities they serve is also taking root (Martinez-Uribe & Macdonald, 2009; Molloy & Snow, 2012). This is extending into education in data management and curation as well. Several initiatives in data management and curation education are taking this approach. The Research Data MANTRA project at the University of Edinburgh developed online programs based on needs assessments from postgraduate programs in social science, clinical psychology, and geoscience (EDINA, n.d.). The University of Massachusetts Medical School and Worcester Polytechnic Institute developed *Frameworks for a Data Management Curriculum* for teaching research data management to undergraduate- and graduate-level students in the sciences, health sciences, and engineering disciplines (Piorun et al., 2012).

In some cases, training can leverage materials created within certain research domains to promulgate RDM best practices, tools, and resources. For instance, ecologists and evolutionary biologists can find a number of articles about basic practices they can take to improve data sharing and reproducibility (Borer, Seabloom, Jones, & Schildhauer, 2009; Dryad, 2014; White et al., 2013). Disciplinary frameworks may be useful for synthesizing a guidance document, such as the *Principles for Engineering Research Data Management* created by the University of Bath (Darlington, Ball, Howard, Culley, & McMahon, 2010).

DEVELOPING THE DIL PROJECT

To address our goals of better understanding what data management and curation skills are needed by graduate students in science and engineering disciplines, and more specifically, what roles libraries and information science professionals could play in addressing these skills, we developed the DIL project. If we were successful in answering these two questions, then the DIL project could take the next steps of testing an approach for library-run education for DIL skills. We ultimately strove to build a case for models that academic libraries could implement for their own curricula and programming by designing and implementing case studies of DIL programs. Through our experiences and assessment of these programs, we would then move beyond the unique, individual needs of our home institutions and attempt to create a dialog of these experiences at the community level in order to address data management and curation issues more broadly. Our findings presented in Chapter 3

and the case studies in Chapters 4 through 8 describe our work toward meeting these ambitious goals.

The DIL project got its start by recruiting an initial cohort of librarians to partner with and create a series of educational programs. These librarians, the five DIL project teams illustrated in Table 2.1, developed expertise in this area through following a shared methodological framework. Reviewing the process and outcomes of the our five case study findings, we then created a guide for developing DIL programs (Chapter 9) comprising the materials and resources we created or applied, along with a detailed description of the construction and implementation of each of the educational programs that were created. In addition, we analyzed our work and experiences collectively to identify commons themes or challenges, as well important differences, to generate a guide for others seeking to develop their own DIL programs. Our intent in producing a guide for developing DIL programs and in sharing the materials we developed was to have them serve as resources for librarians and as a catalyst for creating a community of practice.

Structure of the Project

To carry out the DIL project we recruited librarians to form five project teams based at four different locations: two at Purdue University and one each at Cornell University, the University of Minnesota, and the University of Oregon. We recognized that a diverse set of perspectives and skill sets would be required to ensure the success of each project team and so each team was composed of three people: a data librarian, a subject librarian or information literacy librarian, and a faculty researcher from a science or engineering discipline. The data librarians applied their knowledge of data management and handling and data curation standards and best practices to inform a DIL program for the project team. The subject specialist librarians brought their knowledge of the information ecologies of the particular disciplines they served to ensure that their DIL program would be relevant to the specific disciplinary needs. On two of the project teams the data librarian and subject specialist roles were represented in one person, given the nature of their job responsibilities. On these teams, we recruited a librarian with knowledge and expertise in information literacy to serve as a resource in developing the team's DIL program. The information literacy experts on the project also served as resources to the DIL project as a whole and were invaluable in shaping the overall direction of the project. The third team member, a faculty researcher, contributed to the team's understanding of their research community standards and practices in working with data. They allowed their research group to be interviewed and observed, and were interviewed themselves to enable us to obtain this understanding. In addition, they collaborated with their project team on the construction and deployment of the educational programs for their students. We believed that having a direct connection with a faculty researcher was essential to ensure that the resulting DIL program was directly relevant to their students. The five DIL teams in this project are outlined in Table 2.1.

IMPLEMENTING THE DATA INFORMATION LITERACY PROJECT

Our proposal to carry out the DIL project was awarded by the IMLS in October of 2011. The project was implemented in five stages:

TABLE 2.1 *The Five DIL Project Teams and Their Composition*

Institution	Discipline	Data Librarian	Subject Librarian/ Information Literacy Specialist
Purdue University	Electrical and computer engineering	Jake Carlson	Megan Sapp Nelson
Purdue University	Agricultural and biological engineering	Marianne Bracke	Michael Fosmire
Cornell University	Natural resources	Sarah Wright	Camille Andrews
University of Minnesota	Civil engineering	Lisa R. Johnston	Jon Jeffryes
University of Oregon	Ecology/landscape architecture	Brian Westra	Dean Walton

1. Conducting an environmental scan and literature review
2. Interviewing faculty and students
3. Creating the DIL program
4. Teaching the DIL program
5. Assessing its impact

The details of the work performed by each of the project teams in developing and implementing their individual DIL programs are in the case studies presented in Chapters 4 through 8.

Conducting an Environmental Scan and Literature Review

Each of the five teams identified disciplinary resources and perspectives by conducting an environmental scan of the scholarly literature, reports, and other material produced by researchers in the discipline and subdiscipline of their faculty partner for information pertaining to the DIL competencies. Each team performed an environmental scan of existing data repositories, digital libraries, metadata schema, and other resources, standards, and best practices for their discipline or subdiscipline. They shared and discussed results of the literature review and environmental scan to identify common themes.

Interviews of Faculty and Students

The next stage was to conduct interviews with our faculty partners and graduate students. These interviews were question-based using a script and workbook; however, interactive elements were incorporated when possible, allowing the interviewers and interviewees to share stories and ask questions (Ellis, 2008). We had two objectives in conducting the interviews. First, we wanted to gain an understanding of current practices with regard to handling, managing, and curating data in the labs of our faculty partners. In addition to getting a sense of the kinds of data being generated in the lab, we sought to better understand local policies and practices with data. In particular we wanted to understand where and how graduate students acquired their knowledge and skills in working

with data and how effective they were in doing so. Second, we wanted to gain an understanding of the educational needs of graduate students with regard to data from the perspective of the faculty and the graduate students. We sought to obtain this understanding through applying the 12 DIL competencies that we had generated from previous research (see Chapter 1) and asking our interviewees to review and react to them. In developing the interview protocol, we revisited our initial conceptions of the 12 DIL competencies and revised them both to streamline them and to ensure adequate coverage to potential areas of coverage for our educational programs.

Our belief, which was later confirmed in the literature reviews and environmental scans, was that individual disciplines would have unique interpretations, perspectives, and motivations surrounding the management, dissemination, and curation of data. In the interviews, we asked faculty and students to use a 5-point Likert scale to indicate how important they felt it was for graduate students to acquire each of these competencies before they graduated. We then followed up with several questions to learn why they assigned each competency the rating they did.

We also believed that faculty and students would have their own terminologies and definitions for the concepts and activities that encompassed research data from their disciplinary practices, which may vary from the terms and definitions used by library science and information professionals. These two factors made it difficult, if not impossible, for us to craft definitions for each of the 12 competencies. For example, there is yet to be a universally recognized definition for *data quality* that would be understood by everyone we intended to interview. In fact, having such firm definitions would have been counterproductive for our purposes. We wanted the faculty and students to provide us with *their* perspectives on the knowledge and skills that were important to them and to their discipline. Asking them to react to a definition as articulated by librarians could have resulted in responses with limited value in informing educational programming for that discipline. Ultimately, we viewed the 12 DIL competencies as starting points for a broader conversation between the librarians on the DIL project and the faculty and students.

Our interview instruments are available for download at http://dx.doi.org/10.5703/1288284315510.

Instead of attempting to craft authoritative and universal definitions of the competencies, we listed particular skills or abilities that could be included as a component of the competency. We invited the interviewees to suggest other skills that they would consider to fall under each of the competencies. Although this led to some overlapping discussions, this approach enabled us to gain a more thorough and nuanced understanding of faculty and student perspectives. The 12 data competencies and the skills that we associated with each of them for the purposes of the interview are listed in Table 2.2.

The interview protocol was based on the structure of the Data Curation Profiles Toolkit developed at Purdue University (http://datacurationprofiles.org). It consisted of an interview worksheet, with questions for the interviewee to complete in writing during the interview, and an interviewer's manual, which contained follow-up questions for the interviewer to ask based on the written responses of the interviewee. Our interview instruments are are available for download at http://dx.doi.org/10.5703/1288284315510.

The interviews were conducted in the spring and summer of 2012. Eight of the interviews were with faculty. The other 17

TABLE 2.2 *The 12 DIL Competencies and the Skills Used to Associate With Each Competency for the DIL Project Interviews*

Cultures of practice	Recognizes the practices, values, and norms of field, discipline, or subdiscipline as they relate to managing, sharing, curating, and preserving data Recognizes relevant data standards of field (e.g., metadata, quality, formatting) and understands how these standards are applied
Data conversion and interoperability	Is proficient in migrating data from one format to another Understands the risks and potential loss or corruption of information caused by changing data formats Understands the benefits of making data available in standard formats to facilitate downstream use
Data curation and reuse	Recognizes that data may have value beyond the original purpose, to validate research, or for use by others Is able to distinguish which elements of a data set are likely to have future value for self and for others Understands that curating data is a complex, often costly endeavor that is nonetheless vital to community-driven e-research Recognizes that data must be prepared for its eventual curation at its creation and throughout its life cycle Articulates the planning and activities needed to enable data curation, both generally and within his or her local practice Understands how to cite data as well as how to make data citable
Data management and organization	Understands the life cycle of data, develops data management plans, and keeps track of the relation of subsets or processed data to the original data sets Creates standard operating procedures for data management and documentation
Data preservation	Recognizes the benefits and costs of data preservation Understands the technology, resources, and organizational components of preserving data Utilizes best practices in preparing data for its eventual preservation during its active life cycle Articulates the potential long-term value of own data for self or others and is able to determine an appropriate preservation time frame Understands the need to develop preservation policies and is able to identify the core elements of such policies
Data processing and analysis	Is familiar with the basic data processing and analysis tools and techniques of the discipline or research area Understands the effect that these tools may have on the data Uses appropriate workflow management tools to automate repetitive analysis of data
Data quality and documentation	Recognizes, documents, and resolves any apparent artifacts, incompletion, or corruption of data Utilizes metadata to facilitate an understanding of potential problems with data sets Documents data sufficiently to enable reproduction of research results and data by others Tracks data provenance and clearly delineates and denotes versions of a data set

Continued

TABLE 2.2 *The 12 DIL Competencies and the Skills Used to Associate With Each Competency for the DIL Project Interviews*—cont'd

Data visualization and representation	Proficiently uses basic visualization tools of discipline Avoids misleading or ambiguous representations when presenting data in tables, charts, and diagrams Chooses the appropriate type of visualization, such as maps, graphs, animations, or videos, based on an understanding of the reason/purpose for visualizing or displaying data
Databases and data formats	Understands the concept of relational databases and how to query those databases Becomes familiar with standard data formats and types for the discipline Understands which formats and data types are appropriate for different research questions
Discovery and acquisition of data	Locates and utilizes disciplinary data repositories Evaluates the quality of the data available from external sources Not only identifies appropriate external data sources, but also imports data and converts it when necessary, so it can be used locally
Metadata and data description	Understands the rationale for metadata and proficiently annotates and describes data so it can be understood and used by self and others Develops the ability to read and interpret metadata from external disciplinary sources Understands the structure and purpose of ontologies in facilitating better sharing of data
Ethics and attribution	Develops an understanding of intellectual property, privacy and confidentiality issues, and the ethos of the discipline when it comes to sharing and administering data Acknowledges data from external sources appropriately Avoids misleading or ambiguous representations when presenting data

interviews were with current or former graduate students or postdocs of the interviewed faculty, or in one case with a lab technician. Each DIL project team compiled and analyzed its own ratings and responses to inform the development of its program. Each team wrote a summary of results and shared it with other members of the DIL project at an in-person project meeting. The overall findings for each of the 12 competencies are reported in Chapter 3.

With what was learned from the environmental scan and the interviews, each team developed a DIL program that included defined learning goals, educational interventions, and metrics for assessment. In addition to crafting the content of their DIL program, each team negotiated an approach for delivering the content with their faculty partners, as shown in Table 2.3. The approach selected by each team depended on a number of factors, including existing norms and structures of the lab, the amount of time the faculty and students had available to accommodate a DIL program, and available resources to support the program.

TABLE 2.3 *Approaches for Delivering a DIL Program Taken by the Five DIL Teams*

Institution	Discipline	Approach
Purdue University	Electrical and computer engineering	Embedded librarianship
Purdue University	Agricultural and biological engineering	Series of workshops
Cornell University	Natural resources	6-Week mini-course
University of Minnesota	Civil engineering	Hybrid in-person/online course
University of Oregon	Ecology/landscape architecture	One-shot seminar

Each of the project teams delivered their educational program in the fall of 2012, with the exception of the project team at Cornell, which delivered their program in the spring of 2013. The team members recorded their experiences with what worked well and what might be improved, as well as their general impressions and feelings about the delivery of their program. As a part of their program, each team developed assessment mechanisms to determine their success in implementing their learning goals and objectives. In addition to student achievement, student and faculty attitudes were assessed to determine the relevancy and effectiveness of the instruction. The five teams then conducted a collective analysis of the educational interventions to identify patterns and commonalities across experiences in developing DIL programs, as well as account for any significant differences. Finally, the teams wrote detailed reports on their programs and educational approaches. Each account was analyzed and recommendations were made for future iterations of their program. The lessons learned were built into a guide for other practicing librarians presented in this book in Chapter 9.

The DIL project wrapped up in the fall of 2013 with a 2-day Data Information Literacy Symposium held at Purdue University. The intent of the symposium was to exchange information and consider ways and means of building a community of practice on DIL. At the symposium, each of the DIL teams presented their work and shared their experiences through presentations, discussions, and hands-on exercises. The 80-plus librarian and information professional participants were invited to share their own experiences in teaching data competencies at their institutions through multiple directed discussions and activities. Chapter 11 reports on the many areas of consideration for the continued development of DIL that were identified at the symposium and suggests possible avenues for moving forward.

CONCLUSION

Our overarching goals with implementing the DIL project were to gain a better understanding of how librarians could develop educational programs on data management and curation topics and then to articulate directions for the

academic library community to act on the opportunities presented in this area. We developed the overarching methodology and approach outlined in this chapter for this purpose. However, we found that the five DIL project teams diverged from each other in content and approach to develop a high-quality DIL program for their project partner. The second section of this book describes the work of each of the DIL project teams. The third section articulates what we learned collectively from our experiences and charts a course to further developing the 12 DIL competencies and toward forming a community of practice on DIL.

NOTE

Portions of this chapter are reprinted from Carlson, J., Johnston, L., Westra, B., & Nichols, M. (2013). Developing an approach for data management education: A report from the Data Information Literacy project. *International Journal of Digital Curation, 8*(1), 204–217. http://dx.doi.org/10.2218/ijdc.v8i1.254

REFERENCES

Akmon, D., Zimmerman, A., Daniels, M., & Hedstrom, M. (2011). The application of archival concepts to a data-intensive environment: Working with scientists to understand data management and preservation needs. *Archival Science, 11*(3–4), 329–348. http://dx.doi.org/10.1007/s10502-011-9151-4

Australian National University (2013). *ANU data management manual: Managing digital research data at the Australian National University*. Retrieved from http://anulib.anu.edu.au/_resources/training-and-resources/guides/DataManagement.pdf

Borer, E. T., Seabloom, E. W., Jones, M. B., & Schildhauer, M. (2009). Some simple guidelines for effective data management. *Bulletin of the Ecological Society of America, 90*(2), 205–214. http://dx.doi.org/10.1890/0012-9623-90.2.205

Bresnahan, M. M., & Johnson, A. M. (2013). Assessing scholarly communication and research data training needs. *Reference Services Review, 41*(3), 413–433. http://dx.doi.org/10.1108/RSR-01-2013-0003

Byatt, D., Scott, M., Beale, G., Cox, S. J., & White, W. (2013). *Developing researcher skills in research data management: Training for the future—A DataPool project report.* Retrieved from University of Southampton research repository: http://eprints.soton.ac.uk/351026/1/REPORT-Supporting_Researchers-RDM-Training-Final.docx

Christensen-Dalsgaard, B., van den Berg, M., Grim, R., Horstmann, W., Jansen, D., Pollard, T., & Roos, A. (2012). *Ten recommendations for libraries to get started with research data management* [Final report of the LIBER working group on e-science/research data management]. Retrieved from http://www.libereurope.eu/sites/default/files/The research data group 2012 v7 final.pdf

Coulehan, M. B., & Wells, J. F. (2006). *Guidelines for responsible data management in scientific research.* Retrieved from Office of Research Integrity, U.S. Department of Health and Human Services website: http://ori.hhs.gov/images/ddblock/data.pdf

Darlington, M., Ball, A., Howard, T., Culley, S., & McMahon, C. (2010). *Principles for engineering research data management.* Retrieved from University of Bath Online Publication Store: http://opus.bath.ac.uk/22201/1/erim6rep101028mjd10.pdf

Doucette, L., & Fyfe, B. (2013). *Drowning in research data: Addressing data management literacy of graduate students.* Paper presented at ACRL 2013, "Imagine, Innovate, Inspire,"

Indianapolis, IN. Retrieved from http://www.ala.org/acrl/sites/ala.org.acrl/files/content/conferences/confsandpreconfs/2013/papers/DoucetteFyfe_Drowning.pdf

Dryad. (2014). Joint data archiving policy (JDAP). Retrieved from http://datadryad.org/pages/jdap

EDINA (n.d.) About MANTRA. Retrieved from University of Edinburgh website: http://datalib.edina.ac.uk/mantra/about.html

Ellis, C. S. Interactive interview. (2008). In L. M. Given (Ed.), *The SAGE encyclopedia of qualitative research methods* (pp. 444–446). http://dx.doi.org/10.4135/9781412963909.n222

Feldman, A., Divoll, K. A., & Rogan-Klyve, A. (2013). Becoming researchers: The participation of undergraduate and graduate students in scientific research groups. *Science Education, 97*(2), 218–243. http://dx.doi.org/10.1002/sce.21051

Frugoli, J., Etgen, A. M., & Kuhar, M. (2010). Developing and communicating responsible data management policies to trainees and colleagues. *Science and Engineering Ethics, 16*(4), 753–762. http://dx.doi.org/10.1007/s11948-010-9219-1

Gabridge, T. (2009). The last mile: Liaison roles in curating science and engineering research data. *Research Library Issues: A Bimonthly Report from ARL, CNI, and SPARC, 265,* 15–21. Retrieved from http://old.arl.org/bm~doc/rli-265-gabridge.pdf

Goldstein, S. (2010). Data management, information literacy and DaMSSI. Retrieved from Research Information Network website. http://www.rin.ac.uk/our-work/researcher-development-and-skills/data-management-and-information-literacy

Goldstein, S. (2011). The role of research supervisors in information literacy. Retrieved from Research Information Network website: http://www.rin.ac.uk/our-work/researcher-development-and-skills/information-handling-training-researchers/research-superv

Graham, A., McNeill, K., & Stout, A. (2011). *Managing research data 101.* Retrieved from MIT Libraries website: http://libraries.mit.edu/guides/subjects/data-management/Managing_Research_Data_101_IAP_2011.pdf

Hahn, E. (2012). Video lectures help enhance online information literacy course. *Reference Services Review, 40*(1), 49–60.

Hoffmann, D., & Wallace, A. (2013). Intentional informationists: Re-envisioning information literacy and re-designing instructional programs around faculty librarians' strengths as campus connectors, information professionals, and course designers. *Journal of Academic Librarianship, 39*(6), 546–551. http://dx.doi.org/10.1016/j.acalib.2013.06.004

Hoyer, J. (2011). Information is social: information literacy in context. *Reference Services Review, 39*(1), 10–23. http://dx.doi.org/10.1108/00907321111108088

Johnson, L. M., Butler, J. T., & Johnston, L. R. (2012). Developing e-science and research services and support at the University of Minnesota Health Sciences Libraries. *Journal of Library Administration, 52*(8), 754–769. http://dx.doi.org/10.1080/01930826.2012.751291

Johnston, L., Lafferty, M., & Petsan, B. (2012). Training researchers on research data management: A scalable cross-disciplinary approach. *Journal of eScience Librarianship,* 1(2), Article 2. http://dx.doi.org/10.7191/jeslib.2012.1012

Kumar, S., & Edwards, M. E. (2013). Information literacy skills and embedded librarianship in an online graduate programme. *Journal of Information Literacy, 7*(1), 3–18. http://dx.doi.org/10.11645/7.1.1722

Kumar, S., Wu, L., & Reynolds, R. (2014). Embedded librarian within an online health informatics graduate research course: A case study. *Medical Reference Services Quarterly, 33*(1), 51–59. http://dx.doi.org/10.1080/02763869.2014.866485

Kvenild, C., & Calkins, K. (Eds.). (2011). *Embedded librarians: Moving beyond one-shot instruc-*

tion. Chicago, IL: Association of College and Research Libraries.

Leon-Beck, M., & Dodick, J. (2012). Exposing the challenges and coping strategies of field-ecology graduate students. *International Journal of Science Education, 34*(16), 2455–2481. http://dx.doi.org/10.1080/09500693.2012.713145

Lloyd, A. (2010). *Information literacy landscapes: Information literacy in education, workplace and everyday contexts*. Oxford, UK: Chandos Publishing.

Lloyd, A., & Williamson, K. (2008). Towards an understanding of information literacy in context: Implications for research. *Journal of Librarianship and Information Science, 40*(1), 3–12. http://dx.doi.org/10.1177/0961000607086616

Martin, J. (2013). Refreshing information literacy: Learning from recent British information literacy models. *Communications in Information Literacy, 7*(2), 114–127.

Martinez-Uribe, L., & Macdonald, S. (2009). User engagement in research data curation. In M. Agosti, J. Borbinha, S. Kapidakis, C. Papatheodorou, & G. Tsakonas (Eds.), *Research and advanced technology for digital libraries* (Lecture Notes in Computer Science, Vol. 5714, pp. 309–314) [SpringerLink version]. http://dx.doi.org/10.1007/978-3-642-04346-8_30

Molloy, L., & Snow, K. (2012). The Data Management Skills Support Initiative: Synthesising postgraduate training in research data management. *International Journal of Digital Curation, 7*(2), 101–109. http://dx.doi.org/10.2218/ijdc.v7i2.233

Parsons, T. (2013). Creating a research data management service. *International Journal of Digital Curation, 8*(2), 146–156. http://dx.doi.org/10.2218/ijdc.v8i2.279

Pausch, L., Popp, M. P. (2000). *Assessment of information literacy: Lessons from the higher education assessment movement* [White paper]. Retrieved from Association of College and Research Libraries website: http://www.ala.org/acrl/publications/whitepapers/nashville/pauschpopp

Piorun, M., Kafel, D., Leger-Hornby, T., Najafi, S., Martin, E., Colombo, P. & LaPelle, N. (2012). Teaching research data management: An undergraduate/graduate curriculum. *Journal of eScience Librarianship, 1*(1), 46–50. http://dx.doi.org/10.7191/jeslib.2012.1003

Polger, M. (2010). The informationist: Ten years later. *Journal of Hospital Librarianship, 10*(4), 363–379. http://dx.doi.org/10.1080/15323269.2010.514556

Qin, J., & D'Ignazio, J. (2010, June). *Lessons learned from a two-year experience in science data literacy education.* Paper presented at the International Association of Scientific and Technological University Libraries, 31st Annual Conference, West Lafayette, IN. Retrieved from http://docs.lib.purdue.edu/iatul2010/conf/day2/5

Rader, H. B. (2002). Information literacy 1973–2002: A selected literature review. *Library Trends, 51*(2), 242–259.

SCONUL Working Group on Information Literacy. (2011). *The SCONUL seven pillars of information literacy: Core model for higher education.* Retrieved from http://www.sconul.ac.uk/sites/default/files/documents/coremodel.pdf

Scott, M., Boardman, R., Reed, P., & Cox, S. (2013). Research data management education for future curators. *International Journal of Digital Curation, 8*(1), 288–294. http://dx.doi.org/10.2218/ijdc.v8i1.261

Tetherless World Constellation (TWC). (n.d.). Data science course. Retrieved from Rensselaer Polytechnic Institute website: http://tw.rpi.edu/web/Courses/DataScience

University of Michigan (n.d.). Open data: Scientific data management, sharing and reuse [Website]. Retrieved from http://opendata.si.umich.edu/

Vitae. (2014). About the Vitae Researcher Development Framework. Retrieved from https://www.vitae.ac.uk/rdf

Westra, B. (2010). Data services for the sciences: A needs assessment. *Ariadne, 64*. Retrieved from http://www.ariadne.ac.uk/issue64/westra/

White, E. P., Baldridge, E., Brym, Z. T., Locey, K. J., Mcglinn, D. J., & Supp, S. R. (2013). Nine simple ways to make it easier to (re)use your data. *PeerJ PrePrints, 1,* e7v2. http://dx.doi.org/10.7287/peerj.preprints.7v2