CHAPTER 6

Teaching Foundational Data Skills in the Library

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UNDERGRADUATE STUDENTS OFTEN struggle when first asked to locate and evaluate data for use in their own research projects. These skills are often given scant attention in social science curricula that emphasize statistical formulas and software when teaching quantitative methods. Librarians have a unique opportunity to help students develop their data literacy skills, but our existing data services may not be enough. In our eagerness to connect libraries and scholars through data management services, librarians risk leaving behind the data novices. The same outreach and instruction approaches used to teach data skills to seasoned researchers may not be successful with an audience of beginners, nor are they guaranteed to translate well across disciplines. At the same time, we cannot simply provide datasets to these students, relegating them to the role of data consumer as librarians do the work to locate and provide access to data. Librarians working with students in the social sciences can bridge this gap between data consumption and data research expertise through information literacy instruction. Teaching students the skills needed to identify, locate, and evaluate existing datasets is an excellent way to develop students' data literacy skills and jumpstart their transition from being passive consumers of data to becoming active participants in quantitative research. This chapter offers a pedagogical framework and three sample lessons designed to integrate basic data literacy into information literacy instruction for students in the social sciences who are new to quantitative methods and data analysis.

Data Literacy Challenges in the Social Sciences

Introductory courses in quantitative analysis in the undergraduate social science curriculum frequently focus on statistical formulas and software packages. In or-

der to focus on these skills, instructors omit the task of finding context-appropriate data by providing students with a suitable dataset, often one that has acquired canonical status in that discipline. While this approach ensures students have data with variables rich enough to support the statistical methods of the course, it also hides from view an integral step in authentic quantitative research. The Data-Driven Learning Guides published by the Inter-university Consortium for Political and Social Research (ICPSR) take a similar approach, providing lesson plans for exercises that guide students through applying analytical skills like cross-tabulation or comparison of means to predetermined datasets like the American National Election Studies (ANES) or Monitoring the Future.[1] Similar approaches can also be found in the disciplinary pedagogical literature, as in an assignment using the decennial U.S. Census to analyze community demographic trends in an introductory sociology course, or in another using the World Development Indicators to examine claims about globalization.[2] Such exercises are an essential step in training the novice social science researcher in using data from these influential studies but do not teach students the full range of data skills they will need to conduct their own research. The identification and location of datasets is glossed over in curricula that focus on statistical inference methods and software.

Empowering undergraduates to conduct their own quantitative data analysis is increasingly within librarians' reach considering the variety of downloadable data now available and the relative ease of use of the statistical packages included on many campus computers. Yet, librarians should be mindful that linking data novices to sources of data requires more than a technical solution. Unfortunately, we cannot just hook up the correct virtual pipes and let the data flow; simply providing access to data is not enough. Students must make a cognitive leap from analyzing a dataset provided to them to identifying and locating an appropriate dataset to answer a research question of their own.

Teaching this process in a classroom setting poses challenges that may not arise in the one-on-one reference encounter or research consultation. In a classroom, each student may have a different research question, making it difficult to anticipate the variety of specific challenges students may encounter. Partly this is because of the heterogeneous nature of datasets, which are presented in a variety of file formats and methods of access that complicate their use. Furthermore, data do not fit seamlessly into search tools developed around published scholarly materials, such as library catalogs, article indexes, and, most recently, discovery layers. While there are tools useful for finding data within certain disciplines—for example, Federal Reserve Economic Data (FRED) provides access to thousands of time-series datasets from many sources—they are nowhere near as comprehensive as bibliographic tools like WorldCat. When navigating the world of data, therefore, students must develop their own search strategies in order to make up for this deficiency in the available search tools.

In Search of a Data Literacy Pedagogy for Data Novices

The library literature is strangely silent on teaching undergraduate students the primary data literacy skills that advanced researchers and librarians themselves use to identify, locate, and evaluate statistics and datasets—abilities that are prerequisite for students becoming active participants in quantitative research. Instead, discussions of data literacy in librarianship tend to focus on either data reference skills for librarians or data management services designed for expert researchers. With regard to the former, the data reference literature supplies librarians with a wealth of data resources useful for answering reference questions and assisting researchers but usually assumes a central role for the librarian in identifying and providing access to data.[3] This approach may leave students in a passive, consumer role, relying on *librarians*' data literacy skills rather than developing their own abilities to identify and evaluate datasets. Alternatively, Kristin Partlo uses data reference as a teaching opportunity, helping to develop students' data literacy through modeling, structured worksheets, and dialogue to empower data novices in the learning process.[4]

The literature on data management, on the other hand, tends to focus on the needs of expert researchers who have already mastered the skills of data discovery and analysis. Librarians' involvement in data management has expanded beyond its original emphasis on science research and requirements for federal grants, but instruction and outreach in this area are largely based on the data information literacy competencies developed within this expert scientific context.[5] Most recently, Yasmeen Shorish has invited us to include undergraduates in our data management instruction but suggests we use the same curricula, modules, and outreach methods designed for advanced researchers.[6] This assumes undergraduates already possess the same basic data literacy skills we expect of expert researchers and may not account for disciplinary differences. In sum, there appears to be a pedagogical gap between data reference and data management services. Librarians and their social science faculty partners need to develop pedagogical strategies for teaching data novices the primary data literacy skills needed to thrive in quantitative social science research.

Librarians may find inspiration for a new pedagogy of data literacy from the scholarship of teaching and learning in two seemingly disparate disciplines. First, from the data-intensive field of statistics education, the work of Cobb and Moore suggests that before we ask data novices to identify and locate relevant datasets, we should first ensure that students have some experience with data analysis—the reverse order of operations typical of undergraduate research assignments. Cobb and Moore's data analysis will be familiar to information literacy librarians, as it focuses on asking questions about the data, critically examining the context of their collection and presentation, and developing hypotheses about the underlying

phenomena the data describe.† Learning to interpret and critically evaluate existing data are easier skills than trying to operationalize abstract concepts into measurable variables and control for bias while designing an experiment or imagining data yet to be collected. Once students have learned to recognize the potential value and inherent limitations of any given dataset, they can then appreciate the need for careful design and collection techniques and be able to think ahead to their analytical needs when planning for and implementing a data collection project.[7]

A second inspiration for data literacy instruction comes from history education. Sam Wineburg studied the different ways in which experts (historians) and novices (students) read primary source texts, the most common data format in the humanities. The experts engaged this textual data critically, considering the author's purpose, intended audience, and historical context, while the students read for basic comprehension, as they had been taught to do in primary and secondary schools. Based on these findings, Wineburg called on history instructors to teach the analytical heuristics of historians, and more importantly, to apply these techniques to primary sources to promote the critical interpretation of history.[8] Mastering these techniques must almost certainly precede students' ability to imagine relevant primary source materials for a historical question (i.e., hypothesis) and then locate them on their own.

Both the statistical and historical pedagogies outlined here begin with what librarians will recognize as information literacy. While a librarian's experience, like a historian's, is most often with textual sources, numeric data files require the same critical evaluation as the products of scholarly and popular publishing. Further, disciplines fundamentally shape the data they analyze, as do the bureaucratic structures that frequently collect and disseminate data. The students' search for data will be incoherent without some idea of how and why data come into being; teaching about data, therefore, must counter what Ribes and Jackson call the "commodity fictions of data." Independent, skilled student researchers understand that data are not an undifferentiated resource ready to be tapped online, as the common phrase "raw data" may imply, but rather data are produced in scholarly and political contexts.[9] The lessons that follow aim to keep that relationship in the foreground.

Thus, with these pedagogical models to guide us, we present three lesson plans that we have used in one-shot library instruction sessions to help students develop their data literacy skills and make the transition from passive data consumers to creative data scholars. While the lessons were not developed as a sequence, and in fact have been used in different disciplines at three different universities, together they suggest a scaffolded approach. Lesson One introduces the value of secondary data analysis and data search skills through the more familiar search

† These analytical skills are not the same as statistical inference, which Cobb and Moore treat separately and are beyond the scope of this chapter.

for scholarly literature. Lesson Two adds critical evaluation to students' developing repertoire of data skills. Finally, Lesson Three challenges students to identify their own data needs to solve a research problem, an act of scholarly imagination that not only opens the door to more sophisticated secondary data analysis, but may also encourage expert research design practices and foster a readiness for data management services. Based on the needs and existing skills of any group of learners, these lessons can be adapted individually or in sequence to any librarian's local community in order to enhance the data skills of students in a wide range of disciplines.

Lesson One: Discovering Data through the Literature

Our first lesson was created for a sociology research methods class at Bates College that covers a range of methodologies, both quantitative and qualitative. In the year we describe here, the class focused on attitudes toward immigrants among receiving communities, and the library instruction aimed at introducing them to quantitative datasets in a general way. The session was not tied to a specific assignment in this course but was intended to get students thinking about how they might use quantitative datasets for their senior theses, which they are required to write the following year. The lesson accomplished this goal with an activity emphasizing the relationship between datasets and other scholarly literature. In short, students began with a bibliography of journal articles based on quantitative methods, then located the data on which the articles were based.

The lesson also had an ancillary goal, developed by the course instructor and the librarian with the larger learning outcomes of the course in mind, of socializing students in the use of secondary data. For some disciplines, such as economics, the necessity of using data collected for another purpose is relatively obvious. Most students will intuitively grasp that they cannot calculate a nation's gross domestic product themselves. While they may not be specifically familiar with the Bureau of Economic Analysis, it probably will not surprise them that they would have to obtain data from some other entity in order to analyze their topic. However, for disciplines such as sociology that commonly employ techniques such as the sample survey, it is entirely possible for students to collect their own data with tools like SurveyMonkey or Qualtrics. Designing and deploying a local survey is a great learning experience for students, but there are a few drawbacks, mainly that their samples are often limited to acquaintances, and thus their findings have limited generalizability. By instead using a nationally representative dataset collected for another purpose, often by a government agency or research center with far more extensive resources than an undergraduate could muster, students can learn a great deal about sample surveys by example. Unfortunately, some undergradu-

ates may dismiss using someone else's dataset as less authentic than collecting their own. This lesson is intended to counter that notion by showing students that use of secondary data is a standard practice is sociology and other social sciences.

In this lesson, the librarian introduced secondary datasets by approaching the data search problem through the scholarly literature.† The lesson began with a demonstration using an assigned reading. Students had all read, prior to class, a literature review on attitudes toward immigration that is particularly rich in citations to quantitative studies. One of these citations, for Schildkraut's *Americanism in the 21st Century*,[10] was based on a nationally representative survey archived in ICPSR. The librarian demonstrated how to find the survey data in ICPSR and how to interpret the ICPSR study description page and all the important information found there, including study methods, universe, variables, and means of access. At this time, the librarian facilitated a discussion on the advantages and pitfalls of secondary data, including issues of data access and confidentiality, sample size, timeliness, and generalizability of findings.

Next, pairs of students each received a different citation taken from the bibliography of the literature review, all of which were based on quantitative data archived in ICPSR. The librarian challenged them to find the dataset analyzed by the cited article using ICPSR's Bibliography of Data-Related Literature. Once they had found the dataset, students were asked to determine the following information relevant to evaluating the dataset for potential use, and then share their findings with the group:

- What is the universe of the study?
- When were the data collected?
- Are there any restrictions on accessing the data?
- Which variables are related to immigration?

Though some students struggled with the specialized vocabulary of survey methodology, they were all able to quickly locate the data, reinforcing the connection between published research and the data that underlie it.

This exercise was intended to model the experience of entering a topic through an extensive literature review or bibliography, identifying the key datasets related to the topic, and considering how these datasets might be used in their own research, potentially opening up possibilities for when they tackle their own senior theses. While this lesson's focus on existing data risked encouraging what Schrodt describes in "Seven Deadly Sins of Contemporary Quantitative Political Analysis" as "sloth" (reanalyzing over-used datasets again and again instead of seeking out novel or emerging sources of data),[11] for data novices, secondary data analysis provides a valuable opportunity to learn how experts structure and use data, enhancing the sophistication of undergraduate research.

† This is an adaptation of a lesson plan created by Rachel Barlow and available via ICPSR, called Exploring Data through the Research Literature (http://www.icpsr.umich.edu/icpsrweb/instructors/edrl/index.jsp).

Lesson Two: Evaluating Datasets

Our second lesson was designed to support an introductory demography course at the University of Pennsylvania in which students, for their final paper, were asked to analyze data of their own choosing. Because the students had varying levels of quantitative ability—some had taken statistics, some struggled with constructing tables and charts—the actual analysis could be more or less sophisticated, but they were all required to locate relevant data and use them in support of an argument, even if it was only to make an illustrative cross-tabulation. Because students had to choose their own datasets out of a pool of potential datasets vaster and more varied than can be introduced in a single session, the librarian's goal was to teach students strategies for locating data as well as for evaluating and understanding them. In this lesson, the entrée to the data was not the scholarly literature, but rather the sources of data, often government bureaucracies and intergovernmental organizations (IGOs) in this discipline.

To begin the discussion, the librarian asked students to imagine themselves as researchers in search of data to answer a research question, which they would in fact become by the end of the semester. As a data search strategy, they were instructed to ask of their topic, who cares? In other words, which organizations care enough about this topic to collect data about it, as well as have the not-insignificant resources and authority to do so? Students were encouraged to think of government agencies, national statistical offices, and intergovernmental organizations that frequently collect and disseminate population data.

After this discussion, the bulk of the class time was devoted to an activity examining actual data available online from the IGOs and governments discussed above. In a way, the direction is flipped compared with the previous lesson. Instead of progressing from a research question to a data source, the students were given a data source and asked to devise possible questions that could be asked of it. Small groups of students were given an information sheet on a potentially useful dataset from a government agency or IGO, such as the World Bank World Development Indicators, the World Health Organization Global Health Observatory, or the National Center for Health Statistics CDC Wonder. All of the datasets have some mechanism for exploring and analyzing the data online without having to download large, complex files. The information sheet included a URL and a set of questions for students to investigate by visiting the website for the data and exploring the documentation. These questions included:

- How do you describe what data are available?
- What trends, health disparities, or spatial patterns could you investigate using these data?
- Why do you think these data were collected by this organization?

The class session concluded with a group discussion of their findings. Because each dataset had been assigned to more than one group, students were able to

comment on and enlarge upon each other's observations. During the discussion, the librarian redirected the students to the data documentation in response to vague or uncertain responses, underlining the importance of thoroughly understanding the dataset before analysis.

In this activity, students were given some ideas about likely data producers and directed to a selection of commonly used demographic datasets, but those students who did not choose to use these selected datasets in their projects had to make the leap themselves between their topics and other potential sources of data. In these instances, students were encouraged to seek out an in-depth consultation so the librarian could assist them. However, by requiring students to consider potential data sources and explore what data are available, the assignment positioned the students to better formulate research questions, identify data, and carry out an analysis.

Lesson Three: Operationalization

Our last sample lesson was designed for a research analysis class in sociology at Tulane University. Students in this course learn the basics of statistical inference, from simple hypothesis testing to linear regression models, and they often use prepackaged data from the *General Social Survey* and SPSS statistical software to practice these techniques. For the final project, however, students must develop a research proposal that uses existing quantitative data to test a hypothesis relevant to sociology. Students are free to select any dataset so long as it is both accessible to them and appropriate to the research question. In support of this goal, the librarian collaborated with the instructors to create a library instruction session that would teach students how to first break down their research questions into measurable variables and then to identify potential sources of the desired data.

The library session began with an open discussion about the collectors and disseminators of data that might be of use to sociologists. When asked, students considered the questions of who collects data and whether or not they make their data available to the public. Students in this class have already had at least three other sociology courses, so they were generally able to identify government agencies, NGOs, scholars, and private businesses as the typical collectors of data. After a group discussion on why each entity might collect data, the librarian asked students to imagine whether or not these data would be made available to a wider audience, including themselves. Students described a wide spectrum of data sharing or sequestering motives, from government agencies who are often required to share information with citizens except when individual privacy or national security are at stake, to private businesses which likely collect data to support the profit-making endeavor and would prefer to keep this information hidden from potential competitors.

With the class primed to consider the array of potential data collectors and disseminators, the librarian moved to the more challenging learning objective,

the ability to identify measurable variables that will illuminate a given research question, commonly known as operationalization. Gerhan offers librarians some guidance on how to operationalize a question received at the reference desk, and while he hints at ways to engage the user in the process through the reference interview, his focus is primarily on the librarian's ability to deliver a data source deemed appropriate for the user.[12] His advice, however, is readily adaptable to a classroom setting, and with a well-chosen active learning method, students can learn to operationalize problems themselves. Students should also understand that there is no one correct way to operationalize a problem. Different approaches to measuring a phenomenon are often at the heart of scholarly debates, and learning to operationalize is an important skill for students to be able to gather evidence and contribute their own ideas to these conversations.

With the sociology students at Tulane, the librarian provided a sample research question that had been a topic of discussion in the local news: gentrification. To practice operationalizing this phenomenon, the librarian invited students to work in groups and come up with a list of measurable variables that could be used to study the extent and nature of gentrification in New Orleans, Louisiana. After allowing for adequate time, during which the librarian and the course instructor circulated to provide support as needed and noted how students' teamwork supported each other's learning, the groups shared their variables with the class while the librarian compiled a master list on the board. Students successfully identified the standard demographic variables that could be used to measure gentrification, as well as other indicators such as changing housing values, the types of businesses in a neighborhood, and, as a humorous suggestion, the number of hipsters that could be observed over a given period of time. The librarian suggested that the classification of hipster would also need to be operationalized.

With a list of variables on the board, the librarian asked students to connect each variable with a potential source, recalling the discussion that opened the library session. Most of the demographic information was correctly associated with government sources, in particular the U.S. Census. For housing values, which the Census only provides in aggregate by tract or block group, students suggested the real estate industry for more granular data, although this presented a problem of accessibility. With guidance, the students eventually noted that the city government would need the value of individual homes in order to assess and collect property taxes, and the librarian was happy to demonstrate the city government website that provides this information.

The remainder of the library session was given over to students to work on their own research projects, during which the librarian and instructor circulated to provide support as students attempted operationalizing on their own. Students were also encouraged to refer back to the relevant scholarly literature on their topic when they struggled to identify a relevant data source—a reminder of skills students learned in a pre-requisite course, but also reminiscent of the first lesson

plan discussed in this chapter. Based on observations during the library session and students' responses to a one-minute paper asking what they had learned in the session, it appeared that students seemed to grasp the concept of operationalization, and many were successful in identifying relevant variables for their projects. This was then confirmed by follow-up conversations with the instructor on how well students integrated the lesson into their subsequent class discussions, and by students' final projects, which mostly demonstrated successful attempts at operationalizing their research questions.

Conclusion

The three lesson plans offered here represent our efforts to support students as they make the often difficult transition from data consumer to data scholar. By juxtaposing the information skills of our data novices with the expert practices of social science researchers, we identified the range of abilities and dispositions students needed to develop and created learning experiences focused on those areas, data discovery and evaluation in particular. This pedagogical approach seems to have anticipated the Association of College & Research Libraries' new *Framework for Information Literacy in Higher Education*, the early drafts of which were released while we were testing these lesson plans in the classroom. Each "frame" under this new rubric for information literacy outlines the knowledge practices and dispositions of information experts. Librarians in their local contexts are afforded the flexibility to develop learning objectives and teaching strategies most appropriate to their learners and institutions.[13] Additionally, as demonstrated here, the *Framework* can be adapted to particular disciplinary practices and specialized forms of information.

In Lesson One, we used the scholarly literature to show students how researchers often use existing datasets to explore a variety of research questions. Opening students to the possibilities of secondary data analysis in their own research not only models the modes of inquiry common to social science research, but also reinforces the notion of quantitative scholarship as a collaborative endeavor, suggestive of the conversational metaphor of the ACRL *Framework*. In Lesson Two we focused on the evaluation of datasets, considering the authoritative sources of data relevant to the social sciences and the resources necessary to collect data about large populations. While seemingly simple, the evaluation of existing data engages with multiple frames of information literacy, including the nature of authority, the processes by which datasets are created, and the value datasets carry in the cost of their creation and dissemination and in their utility to myriad research questions. Finally, in Lesson Three we asked students to more fully engage in research as inquiry, challenging them to transform their questions into executable research projects. Each of these three lessons engages with some or all of the frames under the new ACRL *Framework for Information Literacy for Higher Education* to assist

students in their development of expert research practices in the social sciences. Librarians are well suited to tackle this task by taking the best practices of data reference services and translating them into the library classroom through sound pedagogy, collaboration with faculty, and a bit of creativity. By harnessing the increasing number of datasets available to students in their library collections and for free online, librarians can help students gain confidence with numeric information sources, build their information literacy and analytical skills, and take an active role in the scholarly enterprise.

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