2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #50102

# Improving Student Learning and Engagement Through a Redesigned Data Management Course

**Ms. Qianjin Zhang, The University of Iowa**

Qianjin ”Marina” Zhang is the Engineering & Informatics Librarian at the Lichtenberger Engineering Library, University of Iowa. She is a member of the Iowa Superfund Research Program, where she provides data management support. In her role as a subject librarian, she offers instruction, reference services, and research consultations for faculty, students, and researchers in engineering and computer science. She holds an M.A. in Information Resources & Library Science and a B.S. in Biotechnology.

**Carol Hollier, The University of Iowa**

Carol Hollier is the liaison librarian to the Departments of Physics & Astronomy, Mathematics, and Statistics & Actuarial Science at the University of Iowa. She provides research support, Open Science training, and reference services to students and faculty in her departments. She also teaches workshops and courses on data management and information literacy courses to undergraduate and graduate students across the sciences. She holds a B.A. in History, an M.A. in Library & Information Science, and a Postgraduate Certificate in Higher Education (PGCHE).

# Improving Student Learning and Engagement Through a Redesigned Data Management Course


## Abstract

Initiated through collaboration between the College of Engineering's Civil and Environmental Engineering department and the University Libraries, a one-credit graduate-level data management course (CEE:5110) had been taught from 2020 to 2024 by a data librarian and an engineering librarian. The course was paused in 2025. This pause, along with a change from the data librarian who no longer had capacity to teach the course to a sciences librarian with extensive teaching experience, provided a good opportunity to restructure the course for its next, 2026, iteration.

Our main redesign aims were to align the course with best pedagogical practice and improve student learning and engagement. We approached this through three channels. First, we used a course map to adjust the order of the modules, which allowed us to review the entirety of the course, balancing readings, hands-on activities, and assignments to improve students' learning experience. Secondly, we worked closely with the university's Center for Teaching to refine the assignments according to the Transparent Assignment Design framework, and to review our course map. Thirdly, we updated the Canvas course site to comply with the national accessibility requirements as well as to enable inclusive learning. In addition, we plan to collect student feedback periodically. We share early observations on lessons learned and successes of the course changes, which should be applicable to any data or information literacy course.


## Introduction

A one-credit graduate-level elective data management course (CEE:5110) was launched in 2020 through the College of Engineering's Civil and Environmental Engineering Department, the result of a partnership between a multidisciplinary research program and the University Libraries [1]. The course was initially designed for trainees in the multidisciplinary research program but was later extended to all graduate students in STEM fields. The course focused on essential practices for data management using materials from Data Carpentry, DataONE, UK Data Service and Go FAIR [2-5], and provided hands-on experience with developing a data management guide and preparing a dataset for sharing [2-3]. The course had been taught four times by a data services librarian and an engineering librarian from 2020 through 2024. The average enrollment was 8 students per year. As the data services librarian was no longer able to teach the course, a sciences librarian with extensive teaching experience stepped in. This transition created a good opportunity to redesign the course for Spring 2026.

The aims of the course redesign were to align the course with best pedagogical practice and improve student learning and engagement. To identify areas for improvement, we reviewed the

past course evaluations. We also conducted an informal interview with a previously enrolled student. While students found the course content useful, they recommended some key areas to enhance learning: clearer and more informative directions on the data management guide assignment, more time to absorb the materials, and more practical activities. To better incorporate student feedback into the redesign, we consulted with the university's Center for Teaching in order to refine assignments and review a course map that ensured a balanced workload and allowed more time for students to absorb the readings. Next, to respond to previous student feedback for more practical activities, we adopted *The Research Data Management Workbook* [6], invited an additional guest speaker to share their real-world experience of data publishing and reuse, and added student presentations. In addition, we updated the Canvas course site not only to comply with the national accessibility requirements but also to ensure an inclusive learning experience.

## Literature Review

As research data management has become more central to the research process—to meet funders' mandates, to aid in research replication and transparency, and to make data findable and reusable—academic libraries' research data management instructional efforts have proliferated. Varying training approaches, including one-off workshops, workshop series, asynchronous online courses, and for-credit courses that target audiences ranging from faculty to undergraduates, have been adopted across institutions and even countries [7-12]. Different approaches have different benefits and challenges. Workshops take less staff time to prepare and deliver and offer trainees flexibility for attendance, but the scope of content that can be delivered is limited by time constraints. Asynchronous online courses also offer flexibility for attendees, and content delivered can be more comprehensive, but the depth and timing of peer and instructor interaction, feedback, and assessment can be limited by the mode of delivery, and research has shown that some students struggle with online learning [13]. A semester-long for-credit course provides space for in-depth discussions on data management issues and the chance to implement each aspect of research data management. This helps graduate students, the next generation of researchers, to consolidate good practices [14]. Such a course does take significant preparation for its launch. For-credit courses tend to be evaluated and reported after the first time of delivery [15-16]. In contrast, our paper about a course that has run repeatedly provides a broad base of observation and experience for evaluation.

## Approaches

### *Adjusting Assignment Topics*

The original assignments included two components: developing a data management guide and preparing a dataset for sharing. Each component consisted of several topic-based assignments shown in Table 1. By the end of the course, these scaffolded assignments would help students

develop a data management guide that could apply to their own work and become familiar with the data sharing process. We reviewed the original assignments and adjusted topics to improve coherence. First, we merged the assignments on describing "data types" and "file format and standards" because they were closely related. Second, we added a new assignment on creating plans for "data preservation, access and reuse" based on the NIH's *Writing a Data Management and Sharing Plan* to make the data management guide comprehensive [17]. Third, we converted the assignment on creating "data deposit metadata" into a practical, in-class activity to foster collaboration. Fourth, while there were originally six assignments in total, we added an additional one, called "Closing the Loop", to give students an opportunity to revise the second-to-last assignment. The revised assignments are listed in Table 2.

*Table 1. Original Course Assignments*

| **Component** | **Assignment** |
|---|---|
| Data Management Guide | Data types |
| | File formats and standards |
| | Data backup and storage |
| Dataset for sharing | Data dictionary |
| | README file |
| | Data deposit metadata |
| | Finding data repositories |

*Table 2. Spring 2026 Course Assignments*

| **Component** | **Assignment** |
|---|---|
| Data Management Guide | Type of data and file formats |
| | Data backup and storage |
| | Data preservation, access and reuse |
| Data file for sharing | Data dictionary |
| | README file |
| | Finding data repositories |
| Closing the loop | |

*Transparent Assignment Design*

After we finalized the assignment topics, we adopted the Transparent Assignment Design framework to enhance clarity and transparency for each assignment. Transparent Assignment Design is part of Transparency in Learning and Teaching (TILT) practices [18]. The TILT practices have shown significant enhancement on students' learning experiences [19, 20]. The Transparent Assignment Design framework consists of three components: purpose, task, and criteria (see Table 3).

*Table 3. Transparent Assignment Design Framework [18]*

| **Component** | **Definition** |
|---|---|
| Purpose | Learning objectives that help students recognize how the assignment will benefit their learning. |
| Task | Steps of the activities that students should follow. |
| Criteria | The characteristics of successful work and how their work will be judged. |

In the purpose component, we explained the rationale to help students understand how this assignment could benefit them. Also in the task component, we provided clear instructions along with one example to help clarify our expectations for students. For example, in the assignment

on creating a data dictionary (see Figure 1), we provided not only an alternate approach (using Data Dictionary Creator Application) for students to choose from, but also an example of a data variable. Because we wanted to require students to update their previous assignment based on our feedback, we decided to preface each assignment with a pre-assignment task. After consultation with a learning design specialist from the Center for Teaching, we chose not to include the criteria because the task instructions provide sufficient guidance.

*Course Map*

To review the entirety of the course, we created a course map based on a template provided by the Center for Teaching. Our course map, provided here as Appendix, included module number, topic, learning objectives, readings, learning activities, and assignments. We used the course map to adjust the order and topics of the modules, and balance readings and assignments. When adjusting the order and topics, for example, we moved the OpenRefine module immediately following the tabular data structure module, so that students could gain hands-on experience cleaning messy data tables with OpenRefine after learning best practices for the tabular data structure. To ensure an equitable distribution of readings and assignments throughout the course, we simplified some readings for certain modules to remove redundancy and moved a few assignments around. We adopted *The Research Data Management Workbook* for learning activities to address previous student feedback for more practical activities. We also invited a guest speaker to talk about data sharing use cases in Module 12, helping students connect FAIR data principles [5] to real-world applications. In addition, we added student presentations to the last module (Module 15) to allow students to showcase discipline-specific data management guides, reflect on implementation challenges, and learn from each other.

*Accessibility*

To comply with the Americans with Disabilities Act Title II Web and Mobile Application Accessibility Rule and enable an inclusive learning experience, we updated the Canvas course site [21]. We prioritized potential changes based on their feasibility, considering the time, effort, and resources needed for revision. For example, to ensure content structure and compatibility with screen readers, we created the syllabus in a Word document with headings, provided readings in HTML or linked to their original HTML sources, and planned to upload lecture slides in PowerPoint rather than PDF. For students without access to Microsoft Office suites, we planned to refer them to the university IT's website where they could download the software. We also used the Canvas' built-in Anthology Ally—an assessment tool which scans uploaded files, provides an accessibility score, and gives precise guidance on how to improve accessibility issues by flagging problems like missing alternative text for images, lack of text and table headers, and insufficient color contrast for readability [22]. In addition, we planned to turn on PowerPoint captions during class sessions.

**Pre-assignment task:** update the type of data and file formats section of your data management guide as needed based on the instructor feedback on the previous assignment.

**Purpose:** Regardless of whether you plan to share your data or not, you need to create good documentation for your dataset. A data dictionary describes your data at the variable level. This assignment will help you or other users understand your dataset without ambiguity or guesswork in years to come.

**Task:**

For this assignment, you will set aside your data management plan and instead create a data dictionary for your own dataset. You can choose to use Data Dictionary Creator Application, or you can create one from scratch.

- If you choose to use Data Dictionary Creator Application [hyperlink], please make sure you download the data dictionary in a CSV file because it cannot save your data. If you're not sure how to use the application, please refer to the YouTube video tutorial [hyperlink].
- If you choose to create a data dictionary from scratch, make sure you include these variable-level attributes in an Excel file when applicable:
    - variable name
    - variable description
    - variable type or format
    - variable units
    - relationship to other variables
    - variable coding values and meanings
    - missing value code
    - known issues with the values (missing values, range of values, etc.)
    - Other important notes necessary to understand your data
- Submit your data dictionary along with a sample of the dataset in a separate tab of the Excel spreadsheet or as a separate file.

**Example of the Task:**

Your data dictionary should describe each variable within your dataset. Variable-level attributes include the variable name, description (or variable label), variable type, and terminology (such as acronyms and abbreviations). Below is an example.

| **Question** | ***Example*** |
|---|---|
| **Variable name** | *Group* |
| **Variable description** | *4 exposure groups* |
| **Variable units** | *N/A* |
| **Data Type** | *text* |
| **Relationship to other variables** | *Partner to variable "tissue", which include adipose, brain, liver and serum* |
| **Variable coding values and meanings** | *Coding values and meanings: CV-LD = conventional with low dose; CV-HD: conventional with high dose; GF-LD = germ-free with low dose; GF-HD = germ-free with high dose* |
| **Known issues with the data** | *N/A* |

*Figure 1. Data Dictionary Assignment*

*Other Pedagogy Strategies*

We planned to collect student feedback periodically through feedback cards. To stimulate students' participation, we posted warm-up questions in Canvas' course discussion forum before class. We also, at the suggestion of our learning design specialist at the Center for Teaching, implemented an attendance policy that deducted two points for each missed class, to increase student incentive to attend class. These changes would be clarified in the syllabus and in the first week of the course.

## Discussion

The course redesign involved refining the assignments using the Transparent Assignment Design framework, creating a course map, making digital learning content accessible, and applying other pedagogical practices. First, applying the Transparent Assignment Design framework allowed us to articulate assignment expectations more clearly and increase transparency for students about not just the how but the why behind each assignment. The pre-assignment tasks were designed to consolidate student learning and ensure they complete the course with applicable research data management plans and data deposits, either for current projects or future work. In the first assignment, most students did a good job of describing their data in detail. Because one student had not started his research and did not have data to work with, we modified the assignments for him in a short period. We asked him to interview a researcher in his field using a Data Curation Profiles toolkit so that he could complete the assignments using other person's data.

Secondly, developing a course map helped us visualize the relationships between modules and distribute assignments more effectively across the course. We also revised the timing of assignments so that students could practice concepts immediately after the lecture, while ensuring that we had sufficient time to grade and provide timely feedback. For example, we postponed the first assignment from Module 1 to Module 2, because putting it in the first week (Module 1) could negatively affect student retention. The course map included weekly learning activities to support active learning, peer-to-peer discussion, and group reflection. To allow each student to speak up in discussion, we regrouped students at tables every other week.

Thirdly, making digital content accessible enabled us to consider inclusive learning from the students' perspective. While the Anthology Ally tool in Canvas helped identify document accessibility issues, it still required us to manually implement fixes, particularly when adding alternative text to screenshots of data tables.

And finally, based on our early observations as the course has begun to run, some of our pedagogical changes are proving successful, while others are not. For example, the weighted attendance policy is incentivizing students to prioritize attending class. Students are fully engaged compared to the previous cohort. However, participation in Canvas' course discussion

forum is less effective than expected, probably because it is not clearly incorporated into the syllabus. Since students enrolled in this course have different STEM disciplinary backgrounds, it is challenging to meet every student's specific data management needs.

## Conclusion

Inclusive pedagogy has become increasingly central in library instruction since active learning and student-centered communication improve the learning experience [23] [24]. Adopting Transparency in Learning and Teaching (TILT) practices further expand inclusive learning in a library teaching context. As the course is a work in progress, we plan to share more lessons learned and successes based on student evaluations in the future. We encourage librarians who wish to improve student learning and engagement to consider applying TILT practices to data/information literacy instruction and collaborating with their Center for Teaching for pedagogical resources and support.

## Acknowledgement

We would like to thank Tamar Bernfeld from the Center for Teaching for her constructive feedback on the assignment revision and course map, and Brian Westra for helping build the foundation for the course as he was one of the instructors for 2020-2024.

## References

[1] Zhang, Q., & Westra, B. (2021). *Embedded Librarians to Support Data-management Needs of a Multidisciplinary Research Program* Paper presented at 2021 ASEE Annual Conference and Exposition, Virtual Conference. https://peer.asee.org/37022

[2] Data Carpentry. https://datacarpentry.org/ (accessed January 20, 2026).

[3] "Data management skillbuilding hub." DataONE. https://dataoneorg.github.io/Education/ (accessed January 20, 2026).

[4] "Research data management." UK Data Service. https://ukdataservice.ac.uk/learning-hub/research-data-management/ (accessed January 20, 2026).

[5] "FAIR principles." Go FAIR. https://www.go-fair.org/fair-principles/ (accessed January 20, 2026).

[6] K. Briney, *The Research Data Management Workbook*: Caltech Library, 2023. [Online]. Available: https://doi.org/10.7907/z6czh-7zx60.

[7] H. González–Vélez, C. Dobre, B. Sánchez–Solis, G. Antinucci, D. Feenan, and D. Gheorghe, "Open Science and research data management: A FAIR European postgraduate programme," in *IEEE International Conference on Big Data*, 2022, pp. 2522–2531, doi: 10.1109/BigData55660.2022.10020931.

[8] G. Timms, "Introducing undergraduates to research data management: A marine science case study-based asynchronous express course," *Science and Technology Libraries,* vol. 43, no. 1, pp. 78–97, 2024, doi: 10.1080/0194262X.2023.2237077.

[9] S. M. Samuel, Y. V. Sevryugina, M. MacEachern, K. Saylor, and R. Woodbrook, "Stepping up to the moment: collaborating on a data management and sharing workshop series," *Journal of the Medical Library Association,* vol. 113, no. 3, pp. 252–258, 2025, doi: https://doi.org/10.5195/jmla.2025.2070.

[10] Z. Xu, X. Zhou, A. Kogut, and J. Watts, "A scoping review: Synthesizing evidence on data management instruction in academic libraries," *The Journal of Academic Librarianship,* vol. 48, no. 3, p. 102508, 2022, doi: 10.1016/j.acalib.2022.102508.

[11] M. Furukawa, K. Ojiro, and K. Yamaji, "Development and analysis of online RDM training course," in *IEEE 7th Global Conference on Consumer Electronics (GCCE)*, 2018, pp. 640–644, doi: 10.1109/GCCE.2018.8574478.

[12] J. H. Holles and L. Schmidt, "Implementing a graduate class in research data management for science and engineering students," *ASEE Annual Conference & Exposition*, 2018.

[13] A. Lomellini, P. Lowenthal, C. Snelson, and J. Trespalacios, "Accessible and inclusive online learning in higher education: a review of the literature," *Journal of Computing in Higher Education,* vol. 37, no. 3, pp. 1306–1329, Sep 2025, doi: 10.1007/s12528-024-09424-2.

[14] J. Thielen, S. M. Samuel, J. Carlson, and M. Moldwin, "Developing and teaching a two-credit data management course for graduate students in climate and space sciences," *Issues in Science and Technology Librarianship,* vol. 2017, no. 86, 2017, doi: 10.5062/F42Z13HQ.

[15] A. L. Whitmire, "Implementing a graduate-level research data management course: Approach, outcomes, and lessons learned," *Journal of Librarianship and Scholarly Communication,* vol. 3, no. 2, 2015, doi: https://doi.org/10.7710/2162-3309.1246.

[16] J. H. Holles and L. Schmidt, "Graduate research data management course content: Teaching the data management plan (DMP)," *ASEE Annual Conference & Exposition*, 2018.

[17] NIH. "Writing a data management & sharing plan." https://grants.nih.gov/policy-and-compliance/policy-topics/sharing-policies/dms/writing-dms-plan (accessed January 16, 2026).

[18] M. A. Winkelmes. "TILT higher ed examples and resources." TILT Higher Ed: Transparency in Learning and Teaching. https://www.tilthighered.com/resources (accessed January 16, 2026).

[19] M. A. Winkelmes, "Transparency in teaching: Faculty share data and improve students' learning," *Liberal Education,* vol. 99, no. 2, p. 48, 2013.

[20] M. A. Winkelmes *et al.*, "Benefits (some unexpected) of transparently designed assignments," *The National Teaching & Learning Forum,* vol. 24, no. 4, pp. 4–7, 2015, doi: 10.1002/ntlf.30029.

[21] "State and local governments: First steps toward complying with the Americans with Disabilities Act Title II Web and Mobile Application Accessibility Rule." ADA.gov. https://www.ada.gov/resources/web-rule-first-steps/ (accessed January 20, 2026).

[22] "Anthology Ally." Anthology. https://www.anthology.com/products/teaching-and-learning/learning-effectiveness/anthology-ally (accessed January 20, 2026).

[23] "ACRL IS Inclusive Pedagogy Committee." ALA. https://www.ala.org/acrl/is/acr-insidvpop (accessed January 16, 2026).

[24] A. Gupta, Y. Liu, T. Lin, Q. Zhong, and T. Suzuki, "Listening to diverse voices: inclusive pedagogy and culturally responsive teaching for library interactions," *Reference Services Review,* vol. 52, no. 1, pp. 66–85, 2024, doi: 10.1108/rsr-04-2023-0042.

Appendix

Course Map

| Module | Topic | Objectives | Readings | Learning Activities | Assignment |
|---|---|---|---|---|---|
| 1 | Introduction to Data Management | 1. Define research data;<br>2. Explain the importance of data management;<br>3. Distinguish between open format versus proprietary formats | NIH data management and sharing policy, etc. | Discussion on recreating someone's analysis from existing data | N/A |
| 2 | Organizing Data | 1. Identify best practices for naming files;<br>2. identify practical tips on file and folder organization | UK Data Service: organizing; version control, etc. | The Research Data Management Workbook, Chapter 3.1 and 3.2 | Type of data and file formats |
| 3 | Tabular Data Structure | Identify mistakes to avoid poor tabular data structure | "Data organization in spreadsheets", etc. | Data Carpentry, data organization in spreadsheets for ecologists | N/A |
| 4 | Reviewing, tidying up data with OpenRefine | Learn to use the software to clean data in a protected HIPAA compliant software | TBD | TBD | N/A |
| 5 | Data Dictionary | 1. Outline key components in data dictionaries;<br>2. Develop a data dictionary using Data Dictionary Creator Shiny app or a template | USDA data dictionaries, etc. | The Research Data Management Workbook, Chapter 2.3 | Data dictionary |
| 6 | Open source tools: R, Python and Git (Guest Speaker) | Identify open source tools for data analysis, manipulation or calculations | TBD | TBD | N/A |
| 7 | Protecting Data | 1. Identify best practices on data storage;<br>2. Classify institutional data;<br>3. Identify practical tips on data security | UK Data Service: storage, security, etc. | The Research Data Management Workbook, Chapter 4.1 | Data storage and backup |
| 8 | FAIR Data Principles | 1. Outline FAIR data principles and why they matter<br>2. Analyze own data to see if it aligns with the principles.<br>3. Identify how to make data FAIR | FAIR principles in translation, etc. | FAIR Data 101 exercises | N/A |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Data Repository | 1. Understand types of repositories<br>2. Identify discipline appropriate repositories<br>3. Practice process of depositing data into a repository | NIH data repositories, publisher examples, etc. | The Research Data Management Workbook, Chapter 6.1 | Finding data repositories |
| 10 | Data Ownership (Guest Speaker) | 1. Distinguish data ownership versus stewardship<br>2. Identify intellectual properties | "Sharing research data and intellectual property law: A primer", etc. | TBD | N/A |
| 11 | Data Sharing | 1. Understand standard data licenses<br>2. Choose appropriate license for own data<br>3. Understand the importance of metadata for data sharing | "Six simple steps to share your data when publishing research articles", etc. | Depositing data into an open data repository such as OSF | Data preservation, access and reuse |
| 12 | Data Sharing Use Case (Guest Speaker) | Connect FAIR data principles to use case | TBD | TBD | N/A |
| 13 | README File & Lab Notebook | 1. Outline key components in lab notebooks;<br>2. Understand the ownership of lab notebooks<br>3. Identify key components in README files;<br>4. Develop a README file using a template | Dryad's "Make your data more usable: README files", etc. | The Research Data Management Workbook, Chapter 2.2 | README file |
| 14 | Data Policy | 1. Gain familiarity with a range of data policies<br>2. Identify policy or policies relevant to research area<br>3. Apply knowledge gained to-date in data management to understanding the specifics of those policies | NIH data policy, Institutional policy, etc. | Looking up data policy | Closing the loop |
| 15 | Student Presentation | 1. Showcase discipline-specific data management guides<br>2. Identify challenges when implementing | N/A | 3-min presentation | N/A |

Note: Sample readings are listed in the Column of Readings.