

The 'elements' of data literacy

Exploring competencies in undergraduate chemistry education

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Background

- ◇ Basic data literacy is the ability to interpret and use data. A range of data competencies are important when graduates apply for jobs and when they enter graduate and professional programs. Increasingly, librarians are being asked to provide instruction on data literacy topics.
- ◇ Instruction is more effective when when discipline critical concepts are taught but studies have shown that even in STEM fields, data skills are taught inconsistently & usually at upper levels or through undergraduate research.

Our team for this research consists of two chemistry professors, a data librarian (formerly a chemist), and a science librarian from three different universities. We were interested in finding ways to create instructional modules that align with concepts being taught in introductory chemistry classes. Instructors are often reluctant to add to their syllabi and may not be comfortable with data literacy instruction.

Research Question

Chemistry is a data intensive field. How well are chemistry instructors preparing students to interpret and use data? Do instructors & students feel that learning data skills is important?

Our study will provide insights into which data literacy competencies are being taught in chemistry undergraduate curricula, in order to explore potential opportunities for advancing data instruction in chemistry and other STEM disciplines.

Methods

Defining Data Literacy

One of the barriers when communicating across disciplines is a difference in the terms used. Our study began by creating a discipline specific set of ten data literacy competencies for undergraduate chemistry. In order to develop data literacy instruction modules, the term 'data literacy' needed to be defined. A matrix of 12 data competencies for graduate students identified by Carson et al. (2011) was reviewed and compared to skills taught in most chemistry courses. Survey questions were created from these 12 competencies.

Survey Development

Survey items were developed using Likert scales and administered to chemistry instructors and students. For the faculty survey, participants indicated how frequently they taught each of data literacy competencies, perceived student mastery of the competencies, and importance of each competency to their students' career or academic success. Survey items for students were created using the same terminologies as those administered to faculty in order to compare their perceptions.

Survey Distribution and Data Collection

Beginning in fall of 2019 we distributed the surveys to science librarians and librarian/chemistry educator listservs. We asked instructors to answer the survey & then distribute the survey to their students. Since the responses from instructors were fewer than those from students, we decided to increase responses by sending individualized emails directly to chemistry faculty. In the spring of 2020 our efforts were suspended due to the Covid-19 pandemic. We resumed distributing the survey in May 2020 and will continue to seek out participants in order to statistically validate our survey.

Data Literacy Competencies for Undergraduate Chemistry

Introduction to Databases

Forming queries in databases to inform research questions or form hypotheses.

Data Discovery

Locating and using data from other researchers, open data sources, or literature.

Data Management

Organizing processed and raw data in separate files. Creating documentation, written procedures or methods for use.

Data Conversion

Changing the structure or format of data files for analysis while protecting against damaging the data.

Quality Assurance

Reviewing data for errors and using consistent protocols and formats during data collection.

Metadata

Understanding the need for adequate description of methods and data and creating documentation to allow others to find, understand and use their data.

Cultures of Practice

Identifying and using data standards and terminologies that are common and accepted across chemistry.

Data Analysis

Knowing and using analysis tools and techniques relevant in chemistry.

Data Visualization

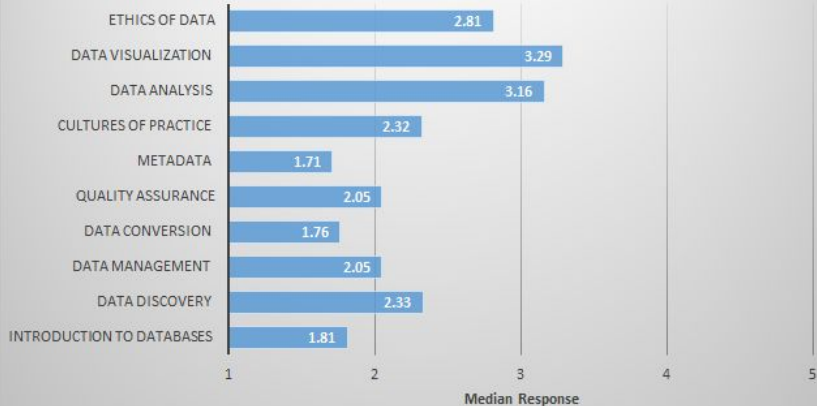
Understanding the accurate use of graphs, plots, diagrams, simulations, and models while avoiding misleading representations.

Ethics of Data

Knowing how to properly cite data to avoid scientific misconduct and data plagiarism.

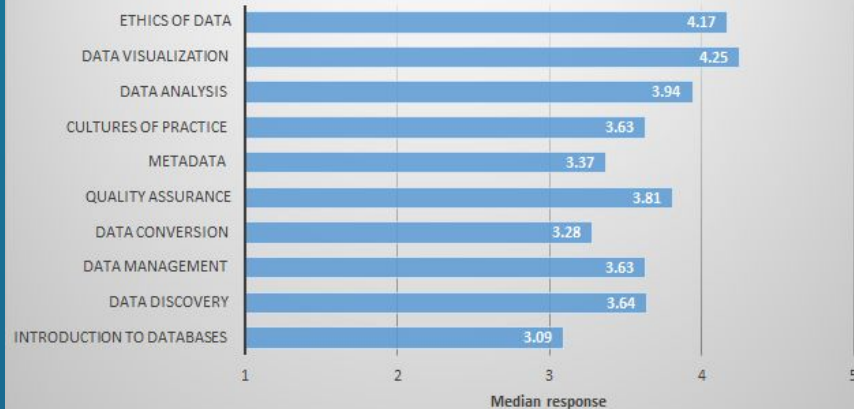
Selected Preliminary Results

How often do you teach the following data literacy concepts in your general or lower level chemistry courses?



Response scale: 1 = never, 3 = sometimes, 5 = always

How important to your students' careers or academic success are these skill areas (competencies)?



Response scale: 1 = not at all important, 5 = extremely important

Some early conclusions

- ◇ Preliminary results with 191 faculty respondents indicated most competencies are infrequently taught and “poorly mastered” by most students.
- ◇ Faculty rated the competencies as “very important” to “extremely important” for students’ career or academic success. Student responses (N=300) revealed similar findings.
- ◇ The most commonly taught competencies were visualization, ethics and analysis, though even for these the median responses hovered only at “sometimes” taught.

Overall, current findings suggest that despite many chemistry instructors’ and students’ awareness of the relevance of data competencies to student academic success and careers, they are rarely implemented.

This study is ongoing. Detailed findings and implications will be discussed in future publications.

Thank you

Are you interested in exploring data literacy? Please help us share the survey with your chemistry faculty! The survey can be found at:

https://info.library.okstate.edu/chemistry_data_literacy

References

- ◇ Carlson, J., Fosmire, M., Miller, C. C., & Nelson, M. S. (2011). *Determining Data Information Literacy Needs: A Study of Students and Research Faculty*. *Portal: Libraries and the Academy*, 11(2), 629–657.
<https://doi.org/10.1353/pla.2011.0022>
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