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Short Communications

COVID-19 as an Opportunity to Expand the Instructional Portfolio of STEM Librarians

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Abstract

The pivot to online teaching caused by the COVID-19 pandemic enabled science and engineering librarians at Vanderbilt University to expand their teaching roles within graduate-level courses in biomedical engineering, chemistry, and physics. In addition to addressing traditional information literacy skills related to information retrieval and resource evaluation, these new lessons addressed important science process skills such as academic reading, responsible conduct of research, and research data management. A facility with cloud-based teaching tools such as Zoom breakout rooms and Excel for Microsoft 365 allowed for engaging instructional experiences, even within synchronous online instructional environments. By integrating these topics into the graduate curricula, these guest lectures supported the professional development of early career graduate students and deepened relationships with the course instructors of record.

Background

Science, technology, engineering, and mathematics (STEM) educators often describe graduate school as the setting where students gain mastery of the processes of scientific research and inquiry (United States Congress 1997). Referred to collectively as science process skills, students over the course of a graduate degree program must develop the ability to generate hypotheses, read and synthesize primary literature, design experiments, visualize and interpret data, think critically, and effectively disseminate results across various mediums (Handelsman et al. 2004). Faculty report that skills such as critical thinking, interpreting data, visualizing data, conducting literature searches, and communicating results are among the most important skills for students to gain (Coil et al. 2010).

Despite their purported centrality to the development of a successful STEM researcher, many graduate students report that these sorts of science process skills are not addressed directly within their formal course work. This disconnect between what students encounter in their formal curriculum, and what skills they are expected to have to succeed, has led to the popularization of the phrase "hidden curriculum" (Bandini et al. 2015; Raso et al. 2019; Calarco 2020). The reliance on students' self-discovery of the importance of the hidden curriculum can have dramatic, negative effects on attempts to recruit and retain students from underrepresented populations in STEM fields (Villanueva et al. 2018). While the origins of the hidden curriculum are contentious, a possible explanation for its persistence is that as highly skilled domain experts, faculty not only think categorically differently than their more novice students, but they also have forgotten entirely how to think like novices (Carroll 2020). Referred to as the "expert blind spot," this phenomenon can prevent faculty from accurately identifying the skills that their early career graduate students need, but do not already possess (Nathan et al. 2001). Furthermore, faculty are required to teach, perform high level research, and take on administrative positions. Their time is limited, and they often delegate research training to graduate students or post-docs that have not received formal instruction in these topics, either.

Academic libraries have attempted to address the hidden curriculum by creating ad-hoc instructional services like workshop series, or by marketing the availability of librarians to offer one-on-one consultations on these topics. However, elective programming like workshops or consultations requires students to engage in help-seeking behaviors to benefit from them. Unfortunately, the culture of graduate school within many STEM programs often inhibits help-seeking, as seeking assistance is stigmatized as a sign of lack of suitability for the rigors of graduate school (Payakachat et al. 2013). Crucially, these stigmas are most likely to be assigned to women and historically underrepresented minorities within STEM programs (Vogt et al. 2007; Inda et al. 2013). Moreover, graduate students of all identities report feelings of chronic fatigue and stress due to overcommitment and overwork (Woolston 2019). As such, overreliance on drop-in workshops or optional consultations may in fact exacerbate the hidden curriculum's ills by failing to offer support to the students most in need of assistance.

However, the literature reflects an increasing awareness from STEM educators that science process skills are sufficiently important that they ought to be integrated strategically into the curriculum (Wallace et al. 1999; Blanco et al. 2014). Librarians frequently report successfully integrating science process skills related to information literacy into curricula (Klem & Weiss 2005). Unlike ad-hoc instructional programming, this model of strategic curriculum-integration enables STEM educators and librarians to deliver contextualized instructional interventions to students that directly connect to the tasks students will be completing in their coursework and ensures a more equitable exposure to the intervention (VanScoy & Oakleaf 2008; Greer et al. 2016; Carroll et al. 2020). However, these training programs typically are limited to searching skills for information retrieval (Maggio & Kung 2014), or in closely related skills like resource evaluation (Blakeslee 2004). Yet, given the expanding skillsets of librarians into areas beyond information retrieval (Auckland 2012; Bakkalbasi et al. 2016), there is a clear opportunity for librarians to expand their curriculum-integrated science process skills instruction to include additional topics.

Institutional Context

Located in Nashville, Tennessee, Vanderbilt University is a private research university with nearly 13,000 students across undergraduate, graduate, and professional degree programs. The Vanderbilt University Libraries consists of nine campus libraries, including the Sarah Shannon Stevenson Science and Engineering Library (SEL). Supporting the science and mathematics departments with the Vanderbilt College of Arts and Letters as well as the Vanderbilt School of Engineering, the SEL prioritizes strategic engagement with academic units through curriculum-integrated instructional programs and developing research support services that align with contemporary researcher workflows (Eskridge & Carroll 2020; Borycz 2021).

COVID-19 and New Instructional Opportunities

While the librarian team at the SEL teaches upwards of 70 information literacy sessions for our user communities annually, like many others, most of these sessions have historically focused on traditional information literacy topics (e.g., literature databases, search strategies, citation management software, etc.). However, when the COVID-19 pandemic forced Vanderbilt to pivot to 100% online education very quickly, many professors had to learn how to use video conferencing and instruction technologies (Bruff 2020a). This disruption to traditional pedagogy led professors in several courses to contact the SEL for assistance in using these technologies and developing/teaching information literacy sessions for their students. There were three courses in which the SEL was asked to provide unique information literacy instruction during the COVID-19 pandemic. The courses were:

1. Professional Development in Chemistry (CHEM 6900), which was designed to give students experience with practical research skills, such as developing research questions, using popular databases, and managing research output efficiently.
2. Engineering Approaches to Cancer in Biomedical Engineering (BME 3890/5890), which consisted of open-ended research questions that involve thesis construction, information retrieval and article writing related to cancer statistics, causes, and potential remedies.
3. A seminar course in Physics (PHYS 8000), which focused on introducing students to state-of-the-art research in physics by exposing them to experts in the field and recently published research papers.

A total of 6 sessions were taught by librarians for the 17 students in CHEM 6900 over the course of the 2020/2021 academic year. These included:

1. A citation management lesson introducing the library webpage, determining relevance, reading papers with the 3-pass approach, creating search alerts, and using a citation manager.
2. A lesson using SciFinder-n, PubChem, and Web of Science with an exercise to practice finding research articles and reviews.
3. An introduction to new tools in SciFinder-n provided by Chemical Abstracts Service.
4. A primer on scientific ethics that focused on copyright, sharing data, plagiarism, and issues with peer review.
5. A data management lesson that described why organizing and sharing data is important, barriers that prevent scientists from sharing data, the research data lifecycle, online repositories, and practical steps for organizing and naming research files.
6. Librarians were also asked to participate in judging a student 3-minute thesis competition that occurred over the final 2 weeks of the course.

One session was taught by librarians for the 25 students in BME 3890/5890 during the Spring semester of 2021. This session focused on finding, evaluating, and describing open data sets and using research databases to find cancer statistics. These resources included the Center for Disease Control (CDC) WONDER, CDC U.S. Cancer Statistics Data Visualizations, the National Cancer Institute's Surveillance, Epidemiology, and End Results Program (NCI SEER), and the NCI Age, Period, Cohort Analysis Tool.

Two sessions were taught by librarians for the 12 students in PHYS 8000 in the Spring semester of 2021. These two sessions included:

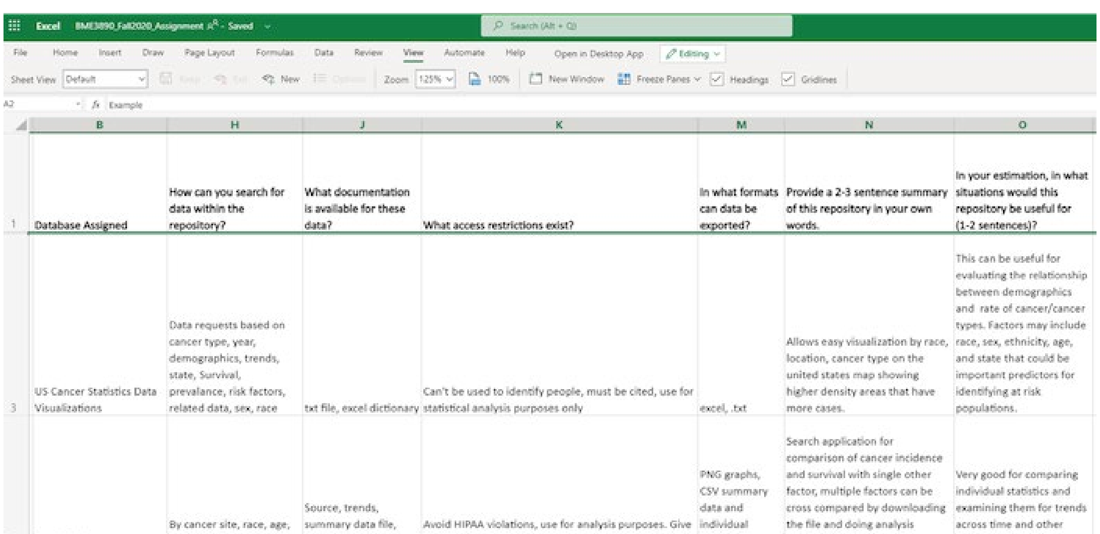
1. How to access and use library resources (Web of Science and Engineering Village) to keep up with the literature, and how to use a citation manager.
2. The structure of scientific articles, how to read them using the 3-pass approach, and research ethics related to peer review, and open data.

Complete course materials for each these lectures, including both slides and exercise templates, are available via OSF (Borycz & Carroll 2020). These materials, licensed under a CC-BY license, can be reused or remixed by other librarians seeking to develop instructional materials on these topics.

Delivering this content during COVID-19

The advent of COVID-19 closures and the increased requests for information instruction meant designing new content related to data management and research ethics would be necessary. However, designing this content from scratch allowed us to approach these pedagogical problems differently; rather than trying to recreate an existing classroom experience, we were free to explore novel ways of creating lessons and exercises suitable for online instruction.

While the now ubiquitous screensharing of PowerPoint slides were a didactic component of each guest lecture, we made frequent use of breakout rooms within Zoom to facilitate more meaningful student engagement with the material. Zoom breakout rooms can promote small group discussions in a way that can be challenging in larger Zoom rooms (Turner 2020), which students often find intimidating and demotivating (Wiederhold 2020). While breakout rooms can create a better space for student discussions, an additional challenge in translating an in-person instructional experience into a synchronous online session is creating opportunities for meaningful, guided practice. Guided practice, far from a bonus, is essential for facilitating student learning. To facilitate guided practice group work in an online setting, we had students in breakout rooms complete exercises using Excel online, in which questions were listed in columns and each group recorded their answers within a single row (see Figure 1).



	B	H	J	K	M	N	O
1	Database Assigned	How can you search for data within the repository?	What documentation is available for these data?	What access restrictions exist?	In what formats can data be exported?	Provide a 2-3 sentence summary of this repository in your own words.	In your estimation, in what situations would this repository be useful for (1-2 sentences)?
3	US Cancer Statistics Data Visualizations	Data requests based on cancer type, year, demographics, trends, state, Survival, prevalance, risk factors, related data, sex, race	txt file, excel dictionary	Can't be used to identify people, must be cited, use for statistical analysis purposes only	excel, .txt	Allows easy visualization by race, location, cancer type on the united states map showing higher density areas that have more cases.	This can be useful for evaluating the relationship between demographics and rate of cancer/cancer types. Factors may include race, sex, ethnicity, age, and state that could be important predictors for identifying at risk populations.
4	Seer* Explorer	By cancer site, race, age, stage, rate type.	Source, trends, summary data file, metholodogy on site.	Avoid HIPAA violations, use for analysis purposes. Give credit for charts.	PNG graphs, CSV summary data and individual entries.	Search application for comparison of cancer incidence and survival with single other factor, multiple factors can be cross compared by downloading the file and doing analysis manually.	Very good for comparing individual statistics and examining them for trends across time and other independent variables.

Figure 1. Worksheet completed by students

To ensure that students had a successful experience working in their groups, we provided detailed instructors, prior to adjourning to breakout rooms, on how to work together, providing suggested norms and group roles for the rooms (see Figure 2).

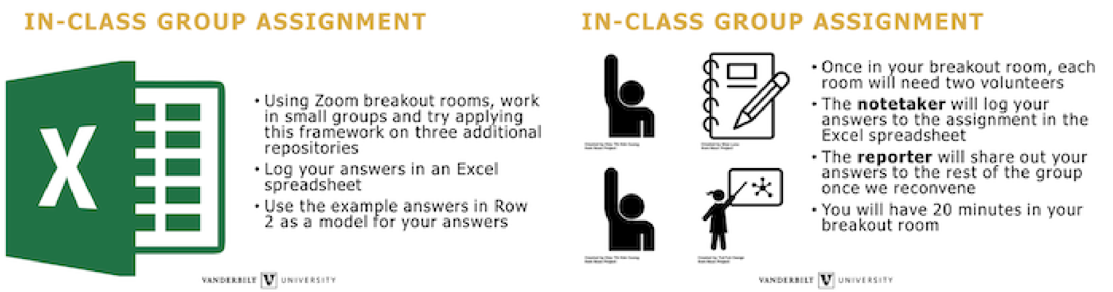


Figure 2. Instructions for students

Breakout rooms separate students from the instructor, but with Excel online, we could monitor each group's effort in real time to determine their thought processes and issues simultaneously, without intimidating them or influencing their answers. Furthermore, we could enter the student breakout rooms to hear their discussions and address questions. Taken together, this creates a facsimile of the experience of walking around a classroom and listening in to student discuss questions posed during an in-class activity (Bruff 2020b).

Lessons Learned

By collaborating with faculty to integrate science process skills into the graduate curricula, we can ensure that we reach all the graduate students within a department at early, critical junctures in their graduate careers. While the curriculum-integrated approach provides the benefit of a captive audience of students, we also saw increased engagement from the students in these sessions. Because the instructor of record has decided that these topics are worthy of a guest lecture, these topics gain the imprimatur associated with a senior faculty member. Furthermore, curriculum-integration also allows for these concepts to be customized by using contextualized, domain-specific examples, which increases the relevance of this content for students and faculty alike (Assor et al. 2002; Klipfel 2014).

Because many of these critical science process topics fall outside the confines of typical coursework, librarians providing this instruction via curriculum-integrated instruction can have a direct impact on the diversity, equity, and inclusion work of the departments they support. By supplementing the drop-in workshop and consultation model with integration into the curriculum, students are not expected to engage in help-seeking behaviors to get the assistance they need because the topics are brought to the students directly. Addressing these critically important concepts via standalone workshops relies on students to independently recognize the limits of their own understanding and overcome the barriers against engaging in help-seeking behavior (Herring and Walther 2016).

By teaching these topics within for-credit classes, we also gained the opportunity to demonstrate our expertise to the instructors of these courses. While the early positive effects of these interactions were anecdotal, we have begun to see more concrete results as well. Since our expansion into these broader topics, undergraduate and graduate program coordinators have begun to approach us about developing similar content for their students unsolicited. This level of deep engagement, where we are viewed as information experts and collaborators, is a marked departure from where our relationships with these departments began.

Finally, designing meaningful, contextualized learning experiences for these science process skills is simply fun. While the fundamentals of information retrieval and expert searching will remain evergreen content for early career graduate students, developing online, synchronous instructional content on these topics provided a refreshing challenge. We look forward to seeing the students in-person during guest lectures in the 2021-2022 academic year, but we intend to continue to take advantage of the opportunities to teach these science process skills upon our return.

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