JOURNAL OF CHEMICAL EDUCATION

Article

pubs.acs.org/jchemeduc

Integration of EndNote Online in Information Literacy Instruction Designed for Small and Large Chemistry Courses

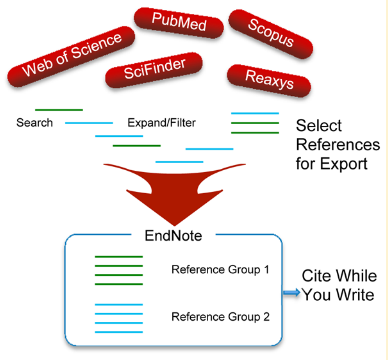
Svetla Baykoucheva,*[,†] Joseph D. Houck,[‡] and Natalia White[‡]

[†]White Memorial Chemistry Library, University of Maryland, College Park, Maryland 20742, United States

[‡]Department of Chemistry and Biochemistry, University of Maryland, College Park, Maryland 20742, Unites States

Supporting Information

ABSTRACT: The blended model for information literacy instruction described in this article introduces students not only to efficient techniques for finding scientific literature and properties of chemical compounds, but also to managing this information with a bibliographic management program (EndNote Online). The model blends face-to-face instruction with online tutorials posted on a LibGuide page prepared for each course. A graded online assignment designed in SurveyMonkey was used to assess student learning. During the instruction, students learned to find literature in Google Scholar, PubMed, Scopus, SciFinder, and Web of Science. They also searched for properties of chemical compounds in ChemSpider, PubChem, Reaxys, and SciFinder using a chemical name, molecular formula, CAS Registry Number, or by drawing a molecular structure. The results from the assignments showed that students learned how to find literature and chemical property information efficiently and use a bibliographic management program to store, organize, share, and cite references. This article presents the implementation of the model in two small (40–60 students) and one large (380–460 students) undergraduate chemistry courses. The information literacy instruction described in this article was carried out in more than 20 undergraduate and graduate courses at the University of Maryland College Park. It provided more than 5000 students with versatile skills that they can use throughout their college education and even later in their professional life. The design of the model and its implementation was a result of a close collaboration between the chemistry librarian and the course instructors.



KEYWORDS: *First-Year Undergraduate/General, Second-Year Undergraduate, Upper-Division Undergraduate, Cheminformatics, Curriculum, Computer-Based Learning, Hands-On Learning/Manipulatives, Internet/Web-Based Learning*

INTRODUCTION

With science becoming more interdisciplinary and complex and the volume of publications growing so quickly, it is becoming increasingly difficult for students and researchers to find and manage scientific information efficiently. Management of scientific information includes how students and researchers perform a search, narrow down results, export references to a bibliographic management program, and insert citations in a Word document. Teaching students how to find chemical information and manage scientific literature more efficiently could help them use such transferable skills not only in a particular course but throughout their college education and later in their professional life.[1]

Information literacy instruction has been a major responsibility of chemistry librarians for decades and many articles describe how such programs were introduced in the chemistry curriculum.[2−8] Two recent books, “Chemical Information for Chemists: A Primer”[9] and “The Future of the History of Chemical Information”[10] include chapters written by experts in chemical information who share their vision of the field and its future. They also provide practical information, which can be very useful to anyone who teaches chemical information or wants to learn more about the chemistry resources.

A new book, “Managing Scientific Information and Research Data,”[11] by one of the authors of this article looks at science information literacy from a broader perspective and in the context of the new technologies and the higher expectations from education. It discusses the new roles that academic librarians could play in supporting education and research in their institutions and how the new areas of eScience, data literacy, data management, and Electronic Laboratory Notebooks (ELNs) can become essential elements of information literacy instruction in the future.

Students are often uncertain which resources they should use to find scientific information. During the instruction, students should be provided with information and comparisons of the resources[12−14] covered in class, so that they can choose the most suitable one. Many resources now are integrated on platforms that allow searching two or more specialized databases at the same time from one access point.[14]

Chemical information instruction conducted in undergraduate courses usually involves educating students about

Special Issue: Chemical Information

DOI: 10.1021/acs.jchemed.5b00515
J. Chem. Educ. XXXX, XXX, XXX−XXX

the general library resources and how to find scientific literature and chemical property information. College students, though, have to write papers and cite literature, which requires using a bibliographic management program to do it efficiently. While the libraries offer workshops on such tools, these events are detached from the curriculum and rarely attract undergraduate students. Bibliographic management programs are sometimes mentioned during library instruction sessions, but this is not enough for students to learn how to use them in practice. There are almost no reports in the literature on incorporating a bibliographic management program as part of chemical information instruction. One article described the incorporation of the reference management program Zotero into a chemical literature course for the purpose of developing proper citation habits in students.[15]

In the past few years, new models of instruction such as flipped and blended formats have been adopted by instructors.[16] The model presented in this article uses a blended format that includes both a face-to-face instruction and online materials and resources. Its main concept is based on the understanding that students need to be introduced to strategies and tools that will allow them to not only find and filter scientific information but also organize and manage this information more efficiently. This article presents results from the implementation of the model in two small (50−60 students) and one large (380−460 students) undergraduate chemistry courses. The close collaboration between a librarian and course instructors was essential for the success of this model.

GENERAL DESIGN

In this model, a bibliographic management program (EndNote Online) is positioned as a central component of the information literacy instruction. Students learn how to use the basic features of this tool in "real life" situations. They perform searches in the literature databases, filter results to make them more manageable, export citations to their EndNote libraries, organize references in groups, create bibliographies, and insert citations in papers they are writing. Finding properties of chemical compounds by using a chemical name, molecular formula, CAS Registry Number, or by drawing a structure is another integral area covered by the instruction.

The model was developed and implemented in more than 20 undergraduate and four graduate courses, as well as in honors and Professional Writing Program courses. The number of students in all courses where this model was implemented was more than 5000.

Assessment of student learning and obtaining feedback from students are important components of an instruction,[17−19] as they help improve the instruction design. Since most of the students were using the resources for the first time, it was important to allow them to practice the new skills through an online assignment, in which the questions included detailed instructions. The level of sophistication of the instruction and the assignment was the same for the three courses, because the students in these courses had not received information literacy instruction before. The questions on the assignment were tailored to the specific course.

The objectives for the instruction model reported and the skills that students were expected to learn are outlined in Boxes 1 and 2, respectively.

Box 1. Objectives for the Information Literacy Instruction Model

Design a model for information literacy instruction that reflects student needs, satisfies the educational requirements of the discipline, and can be adapted to different courses.

Gradually implement the model in courses at all levels.

Generate interest and enthusiasm in students for learning and using the science resources.

Assess student learning and feedback and modify the model, as needed.

Aim at improving student overall standing and retention.

Box 2. Skills That Students Learned from the Instruction

Collect, organize, share, and manage citations with a bibliographic management tool.

Find, filter, and manage scientific literature.

Compare resources and select the best option for finding literature.

Insert citations in Word documents.

Distinguish scientific documents (research paper vs review article).

ELEMENTS OF THE BLENDED INFORMATION LITERACY MODEL

The blended information literacy information model includes face-to-face instruction sessions, online resources, and assessment of student learning. Before coming to class, students had to create accounts for SciFinder and EndNote Online.

Face-to-Face Instruction Sessions

The face-to-face instruction was performed during regular lab periods for 50 min. The sessions for the small courses (CHEM 277 and CHEM 425) were conducted by the librarian (Svetla Baykoucheva), while the sessions for the individual sections of the large course (CHEM 272) were taught by TAs who were trained by her.

Online Components

LibGuide. A LibGuide[20] was used for the instruction to provide access to resources, handouts and other instructional materials, as well as to the online assignment. Individual LibGuide pages were created for each course and can be viewed under the tab "Course materials". The LibGuide course pages and the instructional materials were updated for each semester.

Handouts. Handouts were created for each course to provide detailed instructions on how to use the resources. They were also very helpful to students when doing the assignments because they were based on specific examples relevant to the course and preselected by the instructor. A sample handout is included in the Supporting Information.

Online tutorials helped students understand how to use the resources.

Online assignments are discussed under Assessment of Student Learning. Examples of assignment questions are included on pp 3−12 in the Supporting Information.

Assessment of Student Learning

The assessment of student learning and evaluation of the feedback from students are important parts of the instruction design. Students had to complete an online assignment in SurveyMonkey. A link to the assignment was provided on the

DOI: 10.1021/acs.jchemed.5b00515
J. Chem. Educ. XXXX, XXX, XXX−XXX

course LibGuide page.[20] The results from the assignments were exported to Excel spreadsheets and were analyzed on an individual and group level. The assignment was graded and the grade was included in the total grade of the student for the course.

The assignments included questions related to general search strategies, features of EndNote, and specific questions that required students to search the databases and find the correct answers. The questions fall into the following main categories:

- General questions (the differences between a research article and a review; basic principles for narrowing down search results; using wild cards (for example, an asterisk))
- Basic features of EndNote Online
- Finding and filtering literature
- Finding property information using a chemical name, CAS Registry Number, or drawing a molecular structure.

Some of the questions required finding information in one database and using it to search for other information in another database. Other questions allowed students to apply skills for searching the databases and using EndNote.

The instruction and the assignment also included elements that were specific to the course and the needs of students in preparing reports and doing lab work. Examples of the questions used in the online assignments are included in the Supporting Information. The main goals of the assignment are presented in Box 3.

Box 3. Assignment Goals

Train students, step-by-step, to perform complex searches for finding literature and property information in different databases, and practice the strategies they were shown in class at their own pace.

Assess student learning outcomes (assignment grades were included in the final course grades of the students).

Assess students' ability to successfully follow complex instructions and force them to perform the searches.

Obtain feedback from students about the instruction, the assignment, the instruction format, and the usefulness of the resources.

Assess students' skills for using a bibliographic management program (EndNote Online).

Resources Covered in the Instruction

The resources included in the instruction (shown in Box 4) were the most important science databases that allowed finding literature and property information. They included both free (Google Scholar, PubChem, PubMed, and ChemSpider) and subscription-based databases (Merck Index Online, Reaxys, SciFinder, Scopus, and Web of Science).

EndNote Online (www.myendnoteweb.com) was used as an example of a bibliographic management program,[21] but other similar tools (e.g., Mendeley, Papers, RefWorks, Zotero, and Readcube) were also mentioned during the instruction. More detailed evaluation and comparison of these programs is available elsewhere.[22,23] The training on EndNote allowed students to quickly learn how to use the program. After getting familiar with its basic features, students performed searches in each of the databases, narrowed down results by different criteria and categories, and exported selected references to their EndNote libraries.

Box 4. Resources Covered in the Instruction

EndNote Online (Bibliographic management tool)

Literature databases:

- Google Scholar (free)
- PubMed (free)
- SciFinder (paid subscription)
- Scopus (paid subscription)
- Web of Science (paid subscription)

Chemical property databases:

- ChemSpider (free)
- PubChem (free)
- Reaxys (paid subscription)
- SciFinder (paid subscription)
- Merck Index Online (paid subscription)

PubMed (www.ncbi.nlm.nih.gov/pubmed) (from the U.S. National Library of Medicine of the National Institutes of Health) is a free biomedical resource.[13] It is based on the MEDLINE database.[12,14] Students had to do a search using the advanced (MeSH indexing) features of PubMed, to find only articles that were specifically devoted to the topic they were searching literature for.

Reaxys (www.reaxys.com) (from Reed Elsevier) is a large database that incorporates several databases for chemical property information, as well as a patent database.[24] It provides significantly more information on properties of chemical compounds than PubChem and ChemSpider, as it combines several large chemistry databases. While SciFinder also has these capabilities, structure searching has been demonstrated to students only in Reaxys.

SciFinder (www.cas.org/products/scifinder) allows searching for literature, patents, dissertations, conference proceedings, and properties of chemical compounds. It searches simultaneously two large literature databases (the Chemical Abstracts database (CAplus) and MEDLINE).[14] It also provides access to the Registry File, the largest chemical substance database with property information.

Scopus (www.scopus.com) (Elsevier) is a very large database[12] that was introduced in this model in the fall semester of 2014.

Web of Science (http://webofknowledge.com/WOS) (Thomson Reuters) is a large interdisciplinary database.[12] It is based on the Science Citation Index and is currently part of Web of Knowledge. This database has been used in all courses and during all semesters. Exporting references from Web of Science to EndNote is very easy, because these resources are provided by the same vendor and work well together. Narrowing down results by publication year was emphasized for Web of Science, because, by default, the years are arranged by the number of documents published each year, rather than chronologically. To have the years arranged chronologically, users have to select the "Alphabetical" option.

Details about features of the databases covered in the instruction are included on pp 1−2 in the Supporting Information.

■ IMPLEMENTATION OF THE MODEL

In this paper, we describe the implementation of the information literacy instruction model in three chemistry undergraduate courses: CHEM 272, CHEM 277, and CHEM 425 (Table 1). Table 2 shows the sequence of laboratory chemistry courses at the University of Maryland College Park.

DOI: 10.1021/acs.jchemed.5b00515
J. Chem. Educ. XXXX, XXX, XXX−XXX

Table 1. List of Courses Discussed in the Article

Course	Course Size	Semesters	Sections	Students
CHEM 272[a]	380–460	3	20–22	1,379
CHEM 277[b]	40–50	7	2	329
CHEM 425[c]	50	10	5	500
All students				2,750

[a]General Bioanalytical Chemistry Laboratory (for nonmajors). [b]Fundamentals of Analytical and Bioanalytical Chemistry Laboratory (chemistry and biochemistry majors). [c]Instrumental Methods of Analysis.

Table 2. Sequence of Laboratory Chemistry Courses at the University of Maryland College Park

Course Number (nonmajors/majors)	Course Level
CHEM 132/177	General Chemistry Laboratory I
CHEM 232/237	Organic Chemistry Laboratory I
CHEM 242/247	Organic Chemistry Laboratory II
CHEM 272/277[a]	General Bioanalytical Chemistry Laboratory
CHEM 425[a]	Instrumental Methods

[a]Courses discussed in this paper.

CHEM 272/277 are General Chemistry II Laboratories offered in the fourth semester of the introductory chemistry sequence. This is the final course before upper level chemistry courses in the major (CHEM 425) and the last chemistry course for nonmajors unless students opt to take biochemistry. The CHEM 272 course is for nonmajors and has a large enrollment of pre-health students. CHEM 277 is for chemistry and biochemistry majors. These courses are unique in that many of the experiments have a bioanalytical focus. Students attend one 50 min lecture each week to prepare for the upcoming experiment in addition to the 3-h lab period (CHEM 277 has two 3-h meetings a week). Each week students are asked to complete a post-lab report that requires presentation and analysis of data collected and answering questions relating to theory or concepts involved in the experiment. Many of the exercises in CHEM 272 and CHEM 277 involve finding scientific information such as physical constants of compounds (density, pK_a) or relevant literature to learn more about a particular technique (spectrophotometry, titrations).

CHEM 425 is an instrumental methods of analysis course, a senior level course required by all chemistry and biochemistry majors. It is a four-credit course and fulfils the requirement for the analytical chemistry part of the curriculum. It has both lecture and laboratory components. In the laboratory, students have on average 6–12 h of hands-on experience operating research-grade instrumentation.

Students taking this course have to complete laboratory procedures described in a laboratory manual, but they are also encouraged to come up with original experimental protocols as the final course assignment. In both cases, student work success is directly related to their familiarity with physical and chemical properties of chemicals and the instrumentation setup. In that regard, student ability to pool together literature resources and be able to cite references becomes of critical importance.

The lab portion of the course involved writing 10–11 comprehensive lab reports that were based on the data collected during 6 h of lab work. Part of the lab report was interpretation of the results from a theoretical standpoint and required extensive use of literature to compare the results and find plausible explanations.

Finding information on physical and chemical properties of chemical compounds as well as information on limitations of the analytical methods was also important for general understanding of the experimental setup and was needed later to write a comprehensive "Materials & Methods" section of the report.

Face-to-Face Instruction

The librarian (Svetla Baykoucheva) did this instruction for the smaller courses (CHEM 277 and CHEM 425) and graded the assignments. The face-to-face sessions for the large course (CHEM 272), which was divided into 20–22 sections, were conducted by teaching assistants (TAs) who were trained by the librarian how to cover the material and grade the assignments. In the spring semester of 2014, these sessions took place in computer rooms and students did their assignment immediately after the face-to-face instruction session. In the next two semesters, the sessions of the sections were held in lecture rooms where students brought a laptop or tablet to the instruction.

During the first part of the face-to-face instruction, students were introduced to different publication formats (e.g., research paper, review article, conference proceedings) and some basic principles of searching for literature such as expanding a search using a "wild card", or narrowing down results by time period, document type, and other criteria.

After getting familiar with the basic features of EndNote, students were shown how to perform an online search in PubMed directly from EndNote. This was followed by demonstrating different strategies for performing efficient searches in the literature databases, exporting references to EndNote, organizing and sharing references, creating a bibliography, inserting citations in a Word document, and formatting citations in a particular style.

A major part of the face-to-face instruction was devoted to strategies for finding properties of chemical compounds in several databases by using a chemical name, molecular formula, CAS Registry Number, or by drawing a structure (in Reaxys and SciFinder).

More details about the features of the databases covered in the face-to-face instruction are included on pp 1 and 2 in the Supporting Information.

Grading

The following grading system for the assignments was used (the numbers in parentheses are those of the correct answers): A (9–10), B (8), C (7), and F (<7) Tables 3–5 show the assignment results for the three courses.

Table 3. Distribution of Grades for an Information Literacy Assignment in an Undergraduate Course for Chemistry Nonmajors (CHEM 272) for Three Consecutive Semesters

Course	A	B	C	F	Students[a]
2014 Spring	332	32	5	4	373
2014 Fall	306	55	25	9	395
2015 Spring	311	61	50	9	431

[a]More than 97% of students enrolled in the courses submitted the assignment.

The skills for using EndNote and creating bibliographies were evaluated by including questions in the assignment that required students to perform a search in a database, filter the results, export references to their EndNote libraries, create a bibliography with these references, and copy and paste this

DOI: 10.1021/acs.jchemed.5b00515
J. Chem. Educ. XXXX, XXX, XXX–XXX

Table 4. Distribution of Grades for an Information Literacy Assignment in an Undergraduate Course for Chemistry Majors (CHEM 277) in 6 Semesters

Course	A	B	C	F	Students[a]
2012 Fall	20	3	0	0	23
2013 Spring	28	11	0	4	43
2013 Fall	34	11	1	6	51
2014 Spring	18	5	1	1	25
2014 Fall	43	3	0	0	46
2015 Spring	19	3	0	1	23

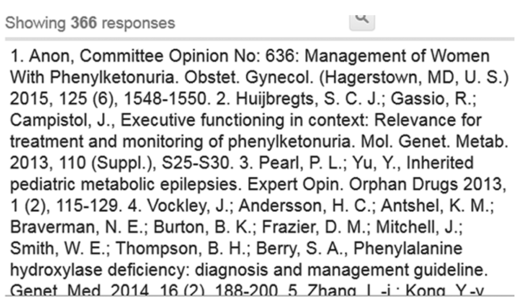
[a]All students enrolled in the courses submitted the assignment.

Table 5. Distribution of Grades for an Information Literacy Assignment in an Undergraduate Chemistry Course (CHEM 425)

Course	A	B	C	F	Students[a]
2011 Fall	24	8	9	3	44
2013 Fall	37	4	2	0	43
2014 Spring	39	6	3	1	49

[a]All students enrolled in the courses submitted the assignment.

bibliography in a box in the online assignment. A screen capture from SurveyMonkey (Figure 1) shows that 366 students in CHEM 272 have responded to such question and have created a bibliography. Examples of assignment questions are included in the Supporting Information.


Showing 366 responses

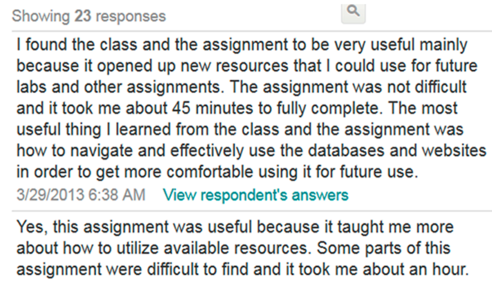
1. Anon, Committee Opinion No: 636: Management of Women With Phenylketonuria. Obstet. Gynecol. (Hagerstown, MD, U. S.) 2015, 125 (6), 1548-1550. 2. Huijbregts, S. C. J.; Gassio, R.; Campistol, J., Executive functioning in context: Relevance for treatment and monitoring of phenylketonuria. Mol. Genet. Metab. 2013, 110 (Suppl.), S25-S30. 3. Pearl, P. L.; Yu, Y., Inherited pediatric metabolic epilepsies. Expert Opin. Orphan Drugs 2013, 1 (2), 115-129. 4. Vockley, J.; Andersson, H. C.; Antshel, K. M.; Braverman, N. E.; Burton, B. K.; Frazier, D. M.; Mitchell, J.; Smith, W. E.; Thompson, B. H.; Berry, S. A., Phenylalanine hydroxylase deficiency: diagnosis and management guideline. Genet. Med. 2014, 16 (2), 188-200. 5. Zhang, L.-i.; Kong, Y.-y.

Figure 1. Screen capture from an assignment in SurveyMonkey showing responses to a question which required performing searches in SciFinder, filtering the search results, exporting references to EndNote Online, and using the latter to create a bibliography with these references. Students had to copy and paste the bibliography they have created in a box in the online assignment. The screen capture is from an assignment for chemistry course CHEM 272. It shows that 366 students have responded to this question. Reproduced with permission from SurveyMonkey.

Feedback from Students

Some of the questions on the assignment were used to obtain feedback from students about the instruction, the assignment, and to rank the resources. For example, students were asked to rank the resources covered during the instruction, by their usefulness. Reaxys and SciFinder were ranked as the most useful ones by many students. A significant number of students chose EndNote as the most useful resource. Learning how to draw chemical structures to find properties of chemical compounds was mentioned by many students as the most important information they had learned from the instruction.

Examples of feedback about the instruction and the assignment are shown in Figure 2.


Showing 23 responses

I found the class and the assignment to be very useful mainly because it opened up new resources that I could use for future labs and other assignments. The assignment was not difficult and it took me about 45 minutes to fully complete. The most useful thing I learned from the class and the assignment was how to navigate and effectively use the databases and websites in order to get more comfortable using it for future use.

3/29/2013 6:38 AM View respondent's answers

Yes, this assignment was useful because it taught me more about how to utilize available resources. Some parts of this assignment were difficult to find and it took me about an hour.

Figure 2. Screen capture from an assignment in SurveyMonkey showing responses from students enrolled in CHEM 277 during the 2015 spring semester to a question about the instruction and the assignment. Reproduced with permission from SurveyMonkey.

More examples of student feedback are included in the Supporting Information.

DISCUSSION

In most cases reported in the literature, information literacy instruction programs introduced in chemistry courses cover only one database, SciFinder.[25−27] The instruction models reported in the literature, even those designed for organic chemistry courses,[28] often do not include structure searching, which would have been very useful to students in such courses. Our model trained students on a much broader range of skills, including structure searching, than the instruction models reported in the literature before.

On the basis of feedback, learning how to draw molecular structures and find property information in SciFinder and Reaxys was of highest importance to students. EndNote was also ranked as one of the most useful programs. Students considered the skills they have learned to be very useful for their success not only in the particular course, but also in other science courses they were currently taking or will be taking in the future. They found them also essential when performing research.

The model presented in this article was first introduced in a senior chemistry course (CHEM 425). Students in that course had not been provided with such instruction earlier and their information literacy skills were quite basic. Many students who were involved in this training expressed regrets that they had not been exposed to these resources much earlier in their college education. After the model was implemented in the earlier courses CHEM 272 and CHEM 277, most of the students taking CHEM 425 were already familiar with most of the resources. Then, the content of the instruction for CHEM 425 was adjusted to reflect the competency level of the students and the specific requirements for the course.

The benefits of the instruction for students were multifold. The hands-on experience was very useful for students, because they were more engaged in the lecture and could perform the searches alongside the live demonstration to be sure they were able to use the databases. Another benefit of the face-to-face instruction was that the students could ask questions of the TA or the librarian. Students were also advised to contact the librarian while writing their papers, and many students chose to use this opportunity.

Because of the complexity of chemical information,[29] instruction in a chemistry course, especially in a large one, presents significant challenges.[30] The most important factor for the success of our model was the collaboration between the course instructors and the librarian who worked closely

DOI: 10.1021/acs.jchemed.5b00515
J. Chem. Educ. XXXX, XXX, XXX−XXX

together in designing and planning the content, logistics, and assessment elements of the instruction. Because of the large number of students who were accessing the databases and EndNote at the same time (all face-to-face sessions were performed in 1 week at the beginning of the semester), the librarian and the instructors had to resolve together any problems. The instructors valued the collaboration with the librarian and relied on her for selection of the resources and how these resources will be introduced to students.

One of the challenges that many academic librarians experience is convincing teaching faculty to include information literacy instruction in their courses. Demonstrating that information literacy instruction will benefit students is the most important factor in changing this attitude. Expanding information literacy to include bibliographic management and other new areas of interest to students and researchers might require reskilling of librarians[31] who need to have working knowledge of these technologies. It also inevitably challenges the current concept of science information literacy and how librarians can contribute to it.[23]

Our future plans are to create a more coordinated program for gradually introducing students in different science courses to more and more sophisticated tools and approaches for finding and managing scientific information and avoid duplication of effort and repetition of content.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

The Supporting Information is available on the ACS Publications website at DOI: 10.1021/acs.jchemed.5b00515.

> Features of databases covered in the instruction, examples of assignment questions for CHEM 272 and CHEM 277, and a sample handout for CHEM 272 and CHEM 277 (PDF, DOCX)

■ AUTHOR INFORMATION

Corresponding Author

*E-mail: sbaykouc@umd.edu.

Notes

The authors declare no competing financial interest.

■ REFERENCES

(1) Ashraf, S. S.; Marzouk, S. A. M.; Shehadi, I. A.; Brian, M. M. An integrated professional and transferable skills course for undergraduate chemistry students. *J. Chem. Educ.* **2011**, *88* (1), 44−48.
(2) Ferrer-Vinent, I. J.; Bruehl, M.; Pan, D.; Jones, G. L. Introducing Scientific Literature to Honors General Chemistry Students: Teaching Information Literacy and the Nature of Research to First-year Chemistry Students. *J. Chem. Educ.* **2015**, *92* (4), 617−624.
(3) Fong, B. L. Searching for the Formula: How Librarians Teach Chemistry Graduate Students Research Skills. *ISTL* **2014**, *75*. DOI: 10.5062/F4J1014M.
(4) Garritano, J. R. Trends in Chemical Information Literacy and Collection Development, 2000−2009. *Sci. .Technol. Libr.* **2010**, *29* (3), 235−257.
(5) Gawalt, E. S.; Adams, B. A Chemical Information Literacy Program for First-year Students. *J. Chem. Educ.* **2011**, *88* (4), 402−407.
(6) Jensen, D.; Narske, R.; Ghinazzi, C. Beyond Chemical Literature: Developing Skills for Chemical Research Literacy. *J. Chem. Educ.* **2010**, *87* (7), 700−702.
(7) Peters, M. C. Beyond Google: Integrating chemical information into the undergraduate chemistry and biochemistry curriculum. *Science and Technology Libraries* **2011**, *30* (1), 80−88.
(8) Peters, M. C., Information competencies for chemistry undergraduates and related collaborative endeavors. *Issues in Science and Technology Librarianship* **2014**, *78*. DOI: 10.5062/F408639D.
(9) Currano, J. N.; Roth, D. *Chemical Information for Chemists: A Primer*; Royal Society of Chemistry: Cambridge, U.K., 2014.
(10) McEwen, L. R.; Buntrock, R. E. *The Future of the History of Chemical Information*, 1st ed.; American Chemical Society: Washington, DC, 2014.
(11) Baykoucheva, S. *Managing Scientific Information and Research Data*; Chandos Publishing (an Imprint of Elsevier): Kidlington, U.K., 2015.
(12) Baykoucheva, S. Selecting a Database for Drug Literature Retrieval: A Comparison of MEDLINE, Scopus, and Web of Science. *STL* **2010**, *29* (4), 276−288.
(13) Baykoucheva, S. A New Era in Chemical Information: PubChem, DiscoveryGate, and Chemistry Central. *Online (Medford, NJ, United States)* **2007**, *31* (5), 16−20.
(14) Baykoucheva, S., Comparison of the Contributions of CAPLUS and MEDLINE to the Performance of SciFinder in Retrieving the Drug Literature. *ISTL* **2011**, *66*. DOI: 10.5062/F42Z13FT.
(15) Kim, T. Building Student Proficiency with Scientific Literature Using the Zotero Reference Manager Platform. *Biochem. Mol. Biol. Educ.* **2011**, *39* (6), 412−415.
(16) Weaver, G. C.; Sturtevant, H. G. Design, Implementation, and Evaluation of a Flipped Format General Chemistry Course. *J. Chem. Educ.* **2015**, *92* (9), 1437−1448.
(17) Mandernach, M. A.; Shorish, Y.; Reisner, B. A. The Evolution of Library Instruction Delivery in the Chemistry Curriculum Informed by Mixed Assessment Methods. *ISTL* **2014**, *77*. DOI: 10.5062/F46H4FDD.
(18) Pan, D.; Ferrer-Vinent, I. J.; Bruehl, M. Library Value in the Classroom: Assessing Student Learning Outcomes from Instruction and Collections. *J. Acad. Libr.* **2014**, *40* (3−4), 332−338.
(19) Bruehl, M.; Pan, D.; Ferrer-Vinent, I. J. Demystifying the Chemistry Literature: Building Information Literacy in First-year Chemistry Students through Student-centered Learning and Experiment Design. *J. Chem. Educ.* **2015**, *92* (1), 52−57.
(20) Baykoucheva, S. Guides for the UMD community. Finding and Managing Scientific Information and Research Data. http://lib.guides.umd.edu/chemistryresources (accessed November 30, 2015).
(21) McKinney, A. EndNote Web: Web-Based Bibliographic Management. *J. Electron. Resour. Med. Libr.* **2013**, *10* (4), 185−192.
(22) Zhang, Y. Comparison of Select Reference Management Tools. *Medical Reference Services Quarterly* **2012**, *31* (1), 45−60.
(23) Baykoucheva, S., Science information literacy and the role of academic librarians. In *Managing Scientific Information and Research Data*, 1st ed.; Chandos Publishing (an Imprint of Elsevier): Kidlington, U.K., 2015; pp 43−63.
(24) Alexander, J. L.; Jürgen, S.-B.; Thibault, G.; David, E. The Making of Reaxys? Towards Unobstructed Access to Relevant Chemistry Information. In *The Future of the History of Chemical Information*; McEwan, L. R., Buntrock, R. E., Eds.; American Chemical Society: Washington, DC, 2014; Vol. *1164*, pp 127−148.
(25) Dawson, P. H.; Jacobs, D. L.; Yang, S. Q. An online tutorial for SciFinder for organic chemistry classes. *Science and Technology Libraries* **2010**, *29* (4), 298−306.
(26) Ferrer-Vinent, I. J. Using in-class Structured exercises to teach sciFinder to chemistry students. *Science and Technology Libraries* **2013**, *32* (3), 260−273.
(27) Ferrer-Vinent, I. J. Teaching sci finder basics to organic chemistry students. *Science and Technology Libraries* **2012**, *31* (2), 164−179.
(28) Swoger, B. J. M.; Helms, E. An organic chemistry exercise in information literacy using scifinder. *J. Chem. Educ.* **2015**, *92* (4), 668−671.

DOI: 10.1021/acs.jchemed.5b00515
J. Chem. Educ. XXXX, XXX, XXX−XXX

(29) Baykoucheva, S. The complexity of chemical information: interview with Gary Wiggins. In *Managing Scientific Information and Research Data*; Baykoucheva, S., Ed.; Chandos Publishing (Imprint of Elsevier): Kidlington, U.K., 2015; pp 97−102.
(30) Locknar, A.; Mitchell, R.; Rankin, J.; Sadoway, D. R. Integration of Information Literacy Components into a Large First-Year Lecture-Based Chemistry Course. *J. Chem. Educ.* **2012**, *89* (4), 487−491.
(31) Brewerton, A. Re-Skilling for Research: Investigating the Needs of Researchers and How Library Staff Can Best Support Them. *New Rev. Acad. Libr.* **2012**, *18* (1), 96−110.

DOI: 10.1021/acs.jchemed.5b00515
J. Chem. Educ. XXXX, XXX, XXX−XXX