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Integrating Bibliographic Software, Database Searching, and Molecular Modeling in an Introductory Biology Course



A Collaboration Between the Biology Department & the Science Librarian

By Charles F. Priore, Jr. and John L. Giannini

Librarians instruct students where to find information, but rarely demonstrate its management, while faculty have difficulty incorporating real-time laboratory experience with library research. This paper focuses on the development of a hands-on biology laboratory experiment in an introductory course that integrates bibliographic software into the lab. The pedagogical and technical issues involved are discussed.

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There is very little documented evidence of the successful implementation of bibliographic software into undergraduate coursework. Though there are a few examples at the graduate level (Harrison 2005), undergraduates are rarely exposed to the power of this technology.

Biology 125 is an introductory cell biology and genetics class taught in the fall semester at St. Olaf College. It is the first course for biology majors but many nonmajors take the class, as well, including psychology, nursing, and sports science majors. The lab component of the class, which is taught as a series of research modules, focuses on teaching students the scientific method and how to write science papers. Students learn a technique (e.g., microscopy or enzyme assays), conduct a multi-week investigative experiment, and finally write a paper in journal format.

Biology 125 has traditionally had a library component as well. First conceived in 1979 as a joint, cooperative effort between the science librarian and faculty members of the St. Olaf College biology department, the assignment, which has always been course integrated, has seen many permutations and revisions over the years. Indeed, when the library component was developed we used typewriters, card catalogs, and paper indices. As the college transitioned to computerized, online catalogs and databases, so too did the assignment. One constant, however, remained: The science librarian taught students how to search for scientific information and was responsible for grading student papers, which included a fully referenced bibliography. The grading process was tedious and time consuming, encompassing approximately four weeks of the science librarian's time. While the assignment provided students with a foundation for later research, there was no follow-up to reinforce these newly learned skills, in part because of the large number of students enrolled in the course (sometimes approaching 280 in four different lecture sections).

As information science has changed over the past decades, so has biology. The emerging field of

bioinformatics dovetails scientific databases such as the Web of Science and Cambridge Scientific Abstracts directly with scientists looking for algorithms via endeavors such as the Human Genome Project. For the first time, these two fields (biology and information science) have become fully integrated. Coupled with this information explosion is the use of bibliographic file management software such as EndNote. We wanted to find a way to introduce students to the power and potential of these emerging technologies.

Our solution

As a means of integrating library information databases and the emerging uses of biology-related databases, a unique exercise was developed. The second experimental module of the semester had been a four-week sequence of labs related to the enzyme peroxidase. In the first three labs, students performed independent (though instructor-guided) experiments to collect data on the physical properties of peroxidase. In week four, the class had a data analysis lab where the instructors talked about what students found and how they would write up their data as a science paper. The following week a paper was due. We expanded the lab series by adding a new lab (the series is now five weeks in duration) at the beginning of the sequence.

This new lab, an introduction to the enzyme peroxidase, emphasizes the use of library databases such as Cambridge Scientific Abstracts and the Web of Science), and molecular modeling databases (three-dimensional structures of biological molecules) found on the web. In preparation, the science librarian gives an in-class lecture on library databases with an assignment that provides students practice using the computer and the bibliographic construction program EndNote. After this lecture and assignment, students are prepared to find references and seamlessly integrate those references into their lab reports.

Technical details

Like most software, EndNote has a moderate to high maintenance factor. Installation must be done over a net-

worked environment (at St. Olaf College we use a Novell server and a close working relationship with the institution's IT department) is essential for proper implementation. EndNote consists of many components, but three are crucial to its success and need consistent maintenance: the filters, the connections files, and the styles folder. The maintenance and updating of these components are the responsibility of the science librarian.

The filters allow users to filter text from a database so that the information is placed into the appropriate fields of the record in an individual's personal library. For example, a library patron who has saved a file from Cambridge Scientific Abstracts' ASFA database would need to use the ASFA filter in order for the appropriate information to make its way completely into a record. These filters change as vendors upgrade their databases, and librarians need to be aware of any inconsistency in data entry and able to either repair filters or, in some cases, create entirely new filters.

The connection files are built in Z39.50 settings that allow users to seamlessly connect with other library

catalogs and some databases. However, included in this folder are connections to many databases that the parent institution does not subscribe or have access to. It is up to a librarian to delete those connections that simply do not work.

In Version 9 of EndNote, the styles folder contains over 1,200 different bibliographic styles, which are germane to particular journals or disciplines. APA, JACS, and MLA are just a few of the hundreds of styles users have to choose from. These styles need to be monitored closely, as newer styles change frequently. By having these three folders (Styles/Connections/Filters) reside on a network server while the actual program software resides on the user's hard drive with their preferences pointing to these folders, it is rather seamless to update all three folders without the knowledge of the user and, more importantly, makes proliferation of these three components a one-step process.

For the molecular modeling part of the class we simply downloaded free molecular modeling software onto PCs located in the laboratory. RasMol and Deepview are modeling

FIGURE 1

Student evaluations.

Question 1. How many science papers did you write in high school?

None	19
One–two	30
Three or more	19
No answer	1

Question 2. Prior to Biology 125, what knowledge did you have of the following?

	None	Some	Very much
Cambridge Scientific Abstracts	45	11	13
Web of Knowledge	59	9	1
EndNote	60	6	3

Question 3. Prior to the lab/library exercise did you have a "working knowledge" of the scientific literature?

Yes	21
No	48

Question 4. Do you feel that you have a better grasp of how scientific literature searching is conducted?

Yes	68
No	1

Question 5. Will you use EndNote software in other classes?

Yes	42
No	7
Maybe	20

programs that use standard protein data bank (PDB) molecular coordinate files. Both programs are easy to use and there is a plethora of databases that have .pdb files for viewing (e.g., the National Institute of Health).

Implementing our solution in the lecture and in the lab

In the library

Our challenge was to introduce three concepts to a group of students that included both majors and nonmajors: database searching, bibliographic management of the information collected, and molecular modeling in a real-life lab setting. Because this group of students is mostly freshman and sophomores with little experience doing database searches, they are first given a sample exercise. This exercise, which is a mock bibliography for a scientific paper, occurs before the peroxidase laboratory begins and prepares students to enter the laboratory with the ability to search the literature in an efficient way. The librarian gives a detailed lecture to all four class sections, complete with handouts describing the mock bibliography, and more specifically, how scientists search and then manage the literature.

Students download an assigned topic from the science librarian's personal web page. These topics are taken directly from the review literature so that there are always plenty of references and citations for students to find during their database searches.

Once students have acquired their topic from the science librarian's web page, they follow a series of steps outlined in their handouts: Define the words in the question using a dictionary or encyclopedia; find one book related to the topic; go to the scientific literature and conduct a search in one of the many databases contained in the Cambridge Scientific Abstracts (CSA) suite; take a paper from CSA and find that paper cited in the literature using Thompson Scientific Web of Knowledge. Students store references as they locate them in their personalized EndNote library. They then produce a mock research paper using EndNote's templates feature and format their paper in the style known as

cell. In the laboratory exercise, students take these skill sets and apply them to an actual lab setting.

In the lab

At the beginning of the lab, students are asked to apply their new knowledge of databases to investigate peroxidase by finding papers on this enzyme's isolation. Eventually, the instructor directs students to a specific publication, where they read about the methods used to isolate peroxidase. The instructor then integrates the paper into a short lecture on protein purification and the class is directed to find papers on the catalytic mechanism of peroxidase. Once again students are steered to a specific publication and given a short lecture on how the enzyme works. The final part of the lab involves an investigation of the molecular structure of peroxidase. Students log on to the National Institute of Health's protein structure database, where they download the molecular coordinates for peroxidase. Using two molecular modeling programs (RasMol and Deepview) to view the 3D structure of the enzyme, students answer questions about its structural components and its active site. The last part of the laboratory is a set of exercises designed to ensure that students can easily repeat these steps with any enzyme.

The integration of this informatics lab in the peroxidase series provides students with a real-world application of what they learned during the science librarian's lecture on library databases and exposes them to the cutting-edge literature available to researchers. These undergraduates use this information to write their final research paper on peroxidase, which is graded by the lab instructor. Probably the most novel aspect of this lab is students' exposure to the molecular modeling databases and viewing programs, the first time to our knowledge that this type of advanced information has been included in an introductory biology class.

Evaluation

Students were asked five questions as part of the final course evaluation.

The responses, based on two lab sections, with a total of 69 students, are described in Figure 1. Our evaluation indicates that at the end of the course students felt confident in using the scientific literature and now have the ability to use bibliographic management tools—two skill sets they did not have prior to this lab.

Conclusion

The first attempt at integrating reference software and the peroxidase series took place in the fall of 2004. We integrated the exercise into all the introductory lab sessions, and provided training for the lab instructors. We repeated this process in the fall of 2005.

The challenge of instructing over 250 introductory students with varying majors has been successfully implemented at the undergraduate level. With careful coordination between the IT department, the science librarian, and the science faculty, large numbers of multidisciplinary students can be exposed to basic scientific search skills from both a library and a laboratory perspective. This new approach has drastically reduced the time previously needed by the science librarian to grade the mock bibliography.

The blueprint for this exercise could be used successfully in other disciplines, such as an introductory chemistry or physics lab. Faculty working in conjunction with their science librarian and IT professionals should be able to implement similar strategies to accomplish information literacy. ■

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Reference

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