

# A Faculty-Librarian Partnership for Investigative Learning in the Introductory Biology Laboratory



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*In this article, we describe our distinct program that connects information literacy to laboratory work, facilitates scientific writing in stages, and continues faculty-librarian partnership throughout a two-course introductory biology sequence.*

Critical thinking and information literacy are essential learning outcomes of a liberal arts education (AAC&U 2007). At Oxford College, first- and second-year students learn to apply critical-thinking and information-literacy skills as they experience being scientists in the laboratory. The Oxford College biology faculty and librarians have worked together to blend the teaching of research methods and to facilitate experiential learning for students. We have developed a layered approach that enables students to build on experiences during the semester, helping them to internalize research skills and transfer their knowledge into the next course.

Library-instruction programs are instrumental in helping students learn how to effectively locate and evaluate good scientific literature resources for their papers. Close collaboration between science faculty and librarians results in the development of strong library-instruction programs for science students (Carle and Krest 1998; Huerta and McMillan 2000; Firooznia and Andreadis 2006). At Oxford College, our faculty-librarian partnership has allowed us to go beyond integrating library instruction into the biology classroom. Our program is distinct from others described in previous publications in several aspects: (1) information literacy is embedded throughout various stages of the research process, specifically con-

nected to laboratory work, (2) students learn to write a primary research article by first writing individual sections of a research manuscript and later writing a complete paper, (3) the faculty-librarian partnership continues into the sequential course, which provides opportunities for students to build on their skills in more advanced contexts. Our objective is to help students conduct productive library research, and to develop their ability to critically select, use, and cite appropriate resources for a scientific manuscript.

### **The laboratory writing assignments**

In our introductory biology curriculum, students take a one-year, two-course sequence in cell biology, genetics, and molecular biology. The laboratory portion of the two courses emphasizes investigative biology and incorporates manuscript-style scientific writing into the learning experience. At the beginning of the first-semester course, students write individual sections of a scientific paper to correspond with short investigative exercises from their laboratory manual (Morgan and Carter 2005). For example, the assignment following the first laboratory exercise on cardiovascular fitness is writing the introduction section of a paper using appropriate reference citations. Successive laboratory exercises are used to write other sections of the paper, such as materials and methods, results, discussion, and abstract. The individual sections stand alone and students can focus on and develop their writing skills for each particular part of a paper. These short assignments also help students hone their library-research skills and provide a way for quick grading and feedback to students on their writing. In the second half of the semester, students work in groups to design their own investigation and conduct the experiment in the laboratory. Each student writes a complete manuscript as a final assignment to describe this research project using skills developed from writing individual sections.

In the second, sequential course, the laboratory portion is purely investigative and a published laboratory manual is not used. Students conduct a short investigation on human genetics at the beginning of the semester and write a complete manuscript to describe their study and analysis. Following this, students design and conduct their own semester-long group research investigation, based on an ongoing faculty research project, for the remainder of the semester. Individually, students write another complete manuscript to report their investigation. This sequential, layered approach facilitates progressive development of scientific-writing and library-research skills for the student's first year in biology.

### **The library-research workshop introduces students to the basics of information literacy and beginning scientific-writing concepts.**

#### **The role of the library**

At the Oxford College Library, the library-instruction program has evolved from a one librarian-run program to a team approach where four librarians coordinate and plan course-specific instruction. In the article "Scholarship of Teaching and Librarians: Building Successful Partnerships with Faculty," (Haines and McNeill 2003) Oxford College librarians discuss the shaping of our instruction program into a multipronged approach that includes

- ♦ collaboration with faculty to design library instruction for student research assignments,
- ♦ individual research consultations,
- ♦ 50-minute library, instruction sessions with hands-on, small-group, active-learning exercises,
- ♦ 20-minute in-class library instruction sessions, or
- ♦ any combination of the above.

Through the partnership between the biology department and the librarians, we have created an ongoing collaboration in the design and content of biology-related instruction programs that includes this multipronged approach. As the Association of College and Research Libraries (2003) notes, helping students develop successful research skills "depends on collaboration among classroom faculty, academic administrators, librarians, and other information professionals." Where others have advocated for entire courses specifically developed with an ongoing library-instruction and research-activities component within the context of the regular class (Carle and Krest 1998; Huerta and McMillan 2000), we have found that co-leading one library-specific research-topic instruction session with the biology faculty and returning at relevant research-related times throughout the semester works well in our context. Using this format, collaboration is defined by the idea that the professor and librarian are co-teaching the instruction session. We work together to discuss the class needs and also take turns to present material and answer questions in the library-instruction sessions, laboratory consultation, and an open-forum session.

The library-research workshop introduces students to the basics of information literacy and beginning scientific-writing concepts. Librarians are invited to participate in the laboratory experience and classroom presentations so that both students and librarians gain the benefits of exposure to one another. The librarians have the opportunity to see and learn what students are researching and the problems they may encounter. As a result, students become more comfortable with asking for help in the research process, and librarians are able to anticipate and understand student questions better after visiting the laboratory. After the initial instruction session, laboratory visit, and attendance at classroom presentations, the faculty and the librarians conduct an open-forum session with

TABLE 1

Scheduled activities of the instruction program in the first-semester course.

Activity	Faculty-librarian collaboration	Assignment
1. Laboratory investigation #1	Faculty only	Introduction and references
2. Library workshop: Active learning	Co-teachers	
3. Laboratory investigations 2–4	Faculty only	Abstract, materials and methods, results and discussion
4. Independent research project	Librarian visits the laboratory	Symposium and full paper
5. Group presentations	Librarian attends the session	
6. Open forum	Co-facilitators	

students before their final paper is submitted. During this forum, students ask questions about their writing, scientific-manuscript format, and literature research. This gives students another opportunity to interact with both the librarian and biology faculty to discuss the research process.

### Working together

For the first course of our introductory curriculum series, we designed a collaborative program for scientific investigation and writing that includes both laboratory and library activities. Table 1 shows the chronological order of our program listing the type of activity, the type of faculty-librarian partnership, and the writing assignment associated with this activity.

In the first laboratory exercise of the semester, students designed a research question and conducted a short investigation from their laboratory manual (Morgan and Carter 2005). Their first laboratory writing assignment was to write an introduction section of a manuscript, with references, to correspond to this laboratory investigation. For preparation, students read the section on scientific writing in their laboratory manual (Morgan and Carter 2005), with particular attention to the instructions for writing an introduction and citing references.

Next, students attended a library-instruction workshop (Activity 2, Table 1). Prior to attending the library session, students were asked to find and bring to the workshop three references they might use in

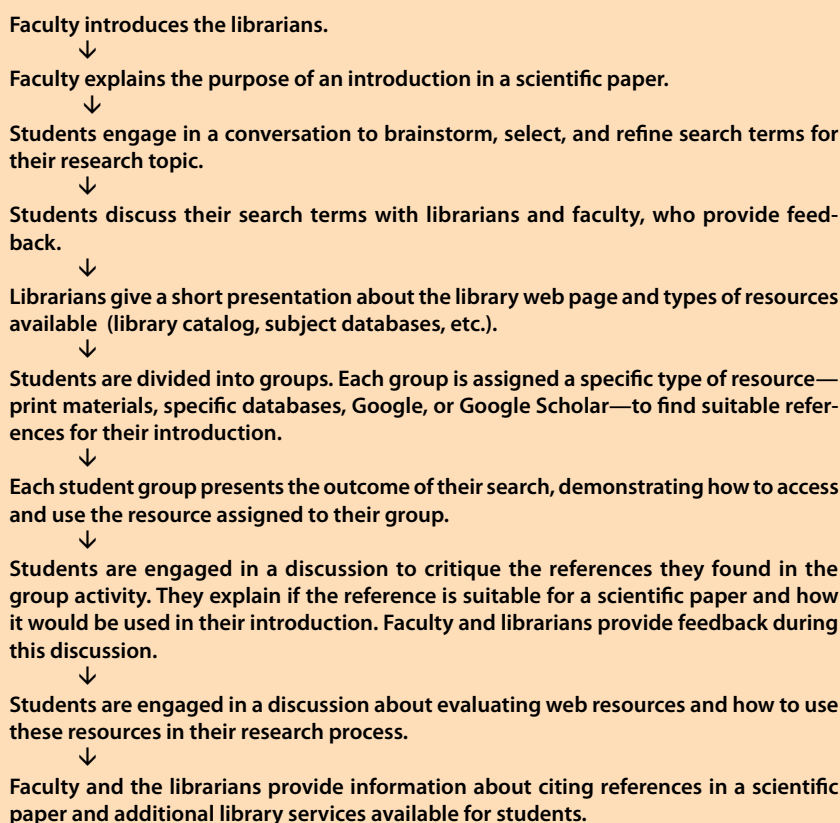
their introduction. Besides their laboratory-manual reading, students had no further instructions on how to search for appropriate resources prior to the library workshop.

We did not specify any criteria for these references to give students the opportunity to compare their own search process to the research skills demonstrated in the library workshop.

The library workshop was conducted with the course instructor and librarians as co-teachers. At the beginning of the workshop, students turned in the three references they brought to the workshop and completed a short survey on the methods they used to find the three references. The objective of the workshop was to give students a hands-on experience in conducting a successful library search. The workshop was designed such that students would leave with at least one appropriate reference for their introduction section. The outline of this student-cen-

FIGURE 1

Outline of the library-workshop session to introduce students to research tools for finding appropriate references.



tered workshop is provided in Figure 1. At the end of the session, students were instructed to use three appropriate references (two journal articles and one other resource), excluding general web resources such as topic-related or broad subject websites, news articles, textbooks, or the laboratory manual for their introduction assignment. For successive writing assignments after this library workshop (Activity 3, Table 1), students were encouraged to apply their library research skills and consult the librarians for individual appointments.

After gaining experience in conducting short investigations and writing individual sections of a scientific manuscript, students conducted a group research project in the second half of the first semester. The librarians visited the laboratory while students were conducting their investigation (Activity 4, Table 1). Students explained their experiment to the librarians and discussed what type of references might be useful to describe their investigation. After completing their laboratory work, student groups presented their investigation and results in a classroom symposium (Activity 5, Table 1). The librarians attended these presentations to gain more information about their individual projects. Following the group presentation, each student wrote a complete manuscript, with all sections, to describe and analyze their laboratory research investigation. This was the final writing assignment in the first-semester course. They were instructed to use five references (including at least three journal articles) and excluding general resources, the textbook, and the laboratory manual. While writing their paper, students were invited to make individual appointments with a librarian. Students were also invited to ask questions during the open-forum session with the librarians and course instructor (Activity 6, Table 1).

In the second-semester course of the introductory sequence, we continued our faculty-librarian partnership to help students apply their knowledge to higher-level projects. Table 2 outlines the activities or projects

**TABLE 2**

**Scheduled activities of the instruction program in the second-semester course.**

Activity	Faculty-librarian collaboration	Assignment
1. Laboratory investigation	Faculty only	Full paper
2. Independent reference search	No instruction	
3. Literature search session	Co-teachers	Research question
4. Laboratory research project	Librarians visit the laboratory	Symposium and full paper
5. Group presentations	Librarians attend the session	

**TABLE 3**

**Survey responses of search tools used by first-semester students prior to library workshop.**

How did you find your three references? (List the tools you used to find these references such as the names of the search engine, database, book index, etc.)	
Type of tool	Percentage of students who used this tool
Search engine (Google, etc.)	37%
Database	34%
Library catalog	12%
E-journal	9%
Miscellaneous	5%
Textbook	3%

in the second semester during which students once again practiced their critical-thinking and information-literacy skills. Students first conducted a short laboratory investigation at the beginning of the semester and wrote a full paper to describe this study (Activities 1 and 2, Table 2). Students were not given any specific criteria for their references and were asked to use their knowledge and research skills from the previous semester to find appropriate references.

Approximately two weeks into the semester, students began a semester-long laboratory research project. They worked in teams to develop an original research question and hypothesis for their project by consulting published literature. To help students with this process, the course instructor and the librarians conducted a literature search

session (Activity 3, Table 2). In this session, students were reminded about selecting appropriate search terms and using appropriate resources to find their references. We discussed the use of primary and secondary resources and how to form a research question. Students worked in their teams to search for appropriate references for formulating their question. The course instructor and the librarians were available for consultation and actively engaged the teams in discussion on their research.

Students conducted several experiments through the course of the semester for their investigations. The librarians visited the laboratory and attended the group presentations (Activities 4 and 5, Table 2). Their presence in the laboratory and at the presentations served to remind students that the li-



TABLE 4

Distribution of the types of references used by first-semester introductory biology students in their writing assignments.

Categories	Pre-library-workshop references	Post-library - workshop references	Final paper
Peer-reviewed journal articles	35%	65%	65%
Books	17%	9%	10%
General: websites, news articles, etc.	48%	26%	25%
Criteria given for assignment	Three references	Three references: two peer-reviewed articles, one other (excluding textbook or general web resources)	Five references: three peer-reviewed articles, two other (excluding textbook or general web resources)

brarians were there for immediate help and to answer quick questions on their topic of investigation. It also helped the librarians to gain a better understanding of the topics students were exploring in their research. After the group presentations, students individually wrote a complete scientific paper describing their investigation, which was their final writing assignment in the second-semester course. In their final paper, students were instructed to cite at least six references, including three journal articles and excluding general news articles, web resources, and textbooks.

### Assessment of student products

Our objective was to help students conduct productive library research and select appropriate resources for their scientific manuscript. To evaluate the impact of our multipronged approach (e.g., the library workshop, librarians visiting the classroom and

laboratory, and application in sequential courses), we took note of the types of references collected by students at different stages. We sorted the references used by students in their assignments into three main categories: (1) peer-reviewed, which included primary and secondary articles, (2) books, and (3) general resources, which included topic-related or broad subject websites or news articles.

In the first-semester course, students searched for three references after reading the suggestions in their laboratory manual and no other special instructions. Students were asked to complete a survey on the methods they used to find references prior to attending the library hands-on session. Student survey responses (Table 3) indicated a higher use of search engines, such as Google, Google Scholar, and Yahoo, to find their preliminary references. In their responses, 34% of students indicated that they used

databases for their search. However, the types of references listed by students did not reflect what they might encounter through a database search, such as primary and secondary research articles. Students made limited use of the library catalog.

We compared these references (pre-library-workshop references) to the types of references that students listed in the introduction assignment, after the hands-on activity of searching for appropriate references (post-library-workshop references). We also compared the references students found at the beginning of the semester to the ones they used in their final paper (Table 4). Almost 50% of the references that students listed prior to the workshop were from general web resources. The laboratory manual, which students were assigned to consult, suggests that the internet should be used only as a tool leading to peer-reviewed sources (Morgan and Carter 2005). The manual also specifies that scientific journals and books are the appropriate resources for a scientific paper. Our data imply that reading the laboratory manual alone did not help students as much as actually reading and applying the information in the library-instruction session.

In the hands-on session, students learned how to select, use, and evaluate databases and general web resources and to find more appropriate peer-reviewed references. Each group presented what they found to the class and explained why the sources were

TABLE 5

Distribution of the types of references used by second-semester genetics students in their writing assignments.

Categories	First paper	Final paper
Peer-reviewed journal articles	82%	84%
Books	8%	6%
General: websites, news articles, etc.	10%	10%
Criteria given for assignment	Three to four references	At least six references: three peer-reviewed articles, three other (excluding textbook or general web resources)

scholarly. This exercise reinforced the laboratory manual's instructions and aided in students' own discovery and identification of scholarly resources. We saw an increase in the use of peer-reviewed articles and a corresponding decrease in the use of general resources in their introduction writing assignment compared to their first attempt (post-library-workshop references, Table 4). This trend remained the same with the references students used in their final papers.

When we review the writing assignments from two courses and their progression throughout each semester, we can see the increase in use of scholarly resources and the retention of this understanding between the classes. In the second-semester course, students used 70–74% more peer-reviewed resources than book or general resources even when no resource criteria were given and without a refresher library workshop for the first paper (Table 5). The increased use of peer-reviewed journal articles demonstrates that students internalized these research skills.

## Conclusions

Based on our results, the hands-on activities of the library workshop (with both the instructor and librarians co-teaching the session) were essential in helping students to change their way of thinking. The involvement of the librarian, along with the instructors' reinforcement of appropriate resources throughout the first semester, helped students transfer their knowledge skills to successive writing assignments into their second semester and develop improved research questions in an advanced course. Students also learned to use the internet as a tool for finding resources while evaluating the differences between peer-reviewed and general resources. Extending the faculty-librarian partnership into sequential courses is an ideal model because students then build on their framework of research skills in successive courses and establish stronger connections with the library resources and staff.

While we were successful at helping students learn and understand the differences between types of sources they could use in their writing, we also took from our evaluation a lesson for future classes. We wanted to measure how much students were learning about appropriate resources and when that learning occurred. After seeing the low use of books in both the intro-

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ductory and advanced classes, we realized the need to focus students on using more book resources, instead of topic-related websites, for general information. We plan to address this during the library-workshop session in the first semester. Regularly reviewing how these classes did at the end of each semester and year also provides us with information we can use to modify the structure of our partnership and future classes. ■

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