Information Literacy in the Lab: Graduate Teaching Experiences in First-Year Biology

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Abstract

The author interviewed ten graduate teaching assistants leading lab sessions for first-year biology about how they introduce students to scientific literature. Qualitative data analysis of the interview transcripts revealed that both first-year students and graduate teaching assistants (many of whom are first-year teachers) struggle with information literacy concepts involved in searching for and evaluating scientific literature. I discuss possible ways that librarians can help.

Introduction

Introductory biology is a pivotal class for life science majors. Success in the sciences hinges on the comprehension of discipline-specific threshold concepts, including understanding how to locate and analyze scientific writing, with the ultimate goal of becoming an effective writer of scientific reports and papers. Most first-year students have their first crucial encounter with scientific literature not in the library, but in the laboratory, as they are introduced to scientific literature not by science faculty or librarians but by teaching assistants. Graduate teaching assistants (GTAs) that lead lab classes play an integral role in conveying the essential skills of locating, evaluating and comprehending scientific articles. This exploratory, descriptive study illuminates how specific research skills are conveyed to first-year science students. A series of in-depth interviews with assistants responsible for teaching lab sections of introductory biology at a research university elicited rich data about how they understand, model and assess information literacy skills.

This study was carried out at a public research institution with nearly 17,000 undergraduates and more than 8,000 graduate students. The Biology Department has nearly 40 full time faculty and more than 100 graduate students teaching 2,000 biology majors. Biology 101 (BIO 101) is an entry-level class covering ecology of species that is required by students majoring in biology or other life sciences. The course is offered every semester with more than 1,000 students taking the course each year. Course goals listed in the syllabus include the ability to “read scientific literature” and “write a laboratory report that conforms to many of the conventions of an

actual scientific paper." A laboratory session entitled "How to Read a Scientific Paper" addresses these skills.

The lab session on finding scientific literature has changed slightly over time, but is essentially the same for all GTAs involved in this study. In the current lab, students are tasked with locating a specific article in a database by using a given description. Details such as the author or the journal title are not provided. The article is not recent and has few citations. Instructors briefly discuss search strategies and have students share their search results after they find the article. The next assignment in the lab builds on these skills: students in groups find a scientific article on a topic of their choosing and present on the different sections of the article (summary, methods, results, conclusions, etc.) and their purpose.

Literature Review

Even though they are responsible for the majority of laboratory instruction, graduate teaching assistants are a comparatively under-studied source of information about teaching science literacy topics (Sundberg et al. 2005). A literature review covering the years 2000 to 2010 revealed that of all research articles that focus on education, only two of the reviewed papers included data on GTAs (Miller 2011). In one study, GTAs participated in focus groups to evaluate student work, and found that students were often confused and frustrated by information literacy topics (Spackman 2007). The study included GTAs' assessment of the course as they taught it and its effect on students, but it did not directly address the GTAs' understanding of information literacy concepts or how these concepts are taught. In a second study, graduate students, also in focus groups, discussed their information needs and use of library resources as teachers and learners (Kuruppu & Gruber 2006). One additional study since 2010 is a 2014 study where librarians employed GTAs to teach information literacy to beginning biology students using a train-the-trainer approach (Hartman et al. 2014).

Librarians have also contributed to the development of information literacy instruction in biology classes. Jacklin and Robinson (2013) described the evolution of library assignments in a biology course from paper-based assignments to online learning modules. Fuselier and Nelson (2011) looked at the information literacy skills taught in first-year biology and tested the effect that a targeted instructional session taught by a librarian had on the mastery of those skills over the course of two semesters. Both studies found the involvement of teaching assistants and faculty instrumental to integrating information literacy content into the class.

The education literature on general teaching and training practices of GTAs further reveals the challenges they face as they transition from student to instructor. A study of the educational and instructional environment of GTA teaching in the sciences at a large research university found that GTAs have little contact with faculty, work independently, and that they "made intuitive decisions, or decisions based on their own experience as students; thus their practices were often disconnected from the literature base in education" (Luft et al. 2004). Another team investigated the train-the-trainer approach, and found that biology GTAs were more comfortable developing personalized approaches to information literacy instruction after training with librarians (Hartman et al. (2014). However, Gregory (2013) observed how time- and labor-intensive the train-the-trainer model is, and found that GTAs were often anxious about covering information literacy topics with students.

Developments in science education further demonstrate the important role of the laboratory course and GTAs' challenge in leading them. The incorporation of inquiry-based learning in the introductory laboratory setting is one intervention by science faculty aimed at increasing student understanding of skills and concepts. Inquiry-based labs challenge students to carry out experiments of their own design to answer research questions as opposed to following a stated set of procedures. French and Russell (2002) surveyed GTAs teaching sections of an introductory biology course teaching with inquiry-based methods and found the method had improved their instruction and understanding of course content, including research skills.

Methodology

Interviews are a common approach to gathering data in a research project. Many researchers testify to the breadth of information gained from interviewing subjects (Doody & Noonan 2013). Interviews are widely used to understand stakeholders' opinions and perspectives, but few researchers have used them to investigate information literacy in biology. In the present study, a semi-structured interview fit the needs of a constructivist inquiry exploring how GTAs taught based on their own learning experiences.

The researcher emailed biology graduate students listed in the course catalog as BIO 101 GTAs. The researcher also collectively invited the larger group of all biology graduate students

to participate in the study. Ten GTAs who were teaching BIO 101 or had taught BIO 101 previously agreed to be interviewed. Interviews ranging from twelve to thirty minutes were recorded and transcribed. One interviewee declined to be recorded and the investigator took notes. All transcriptions and notes were coded thematically using grounded theory (Glaser & Strauss 1967). GTAs were asked about their teaching experience, instruction methods, lab setup and student response (See Appendix).

Findings and Discussion

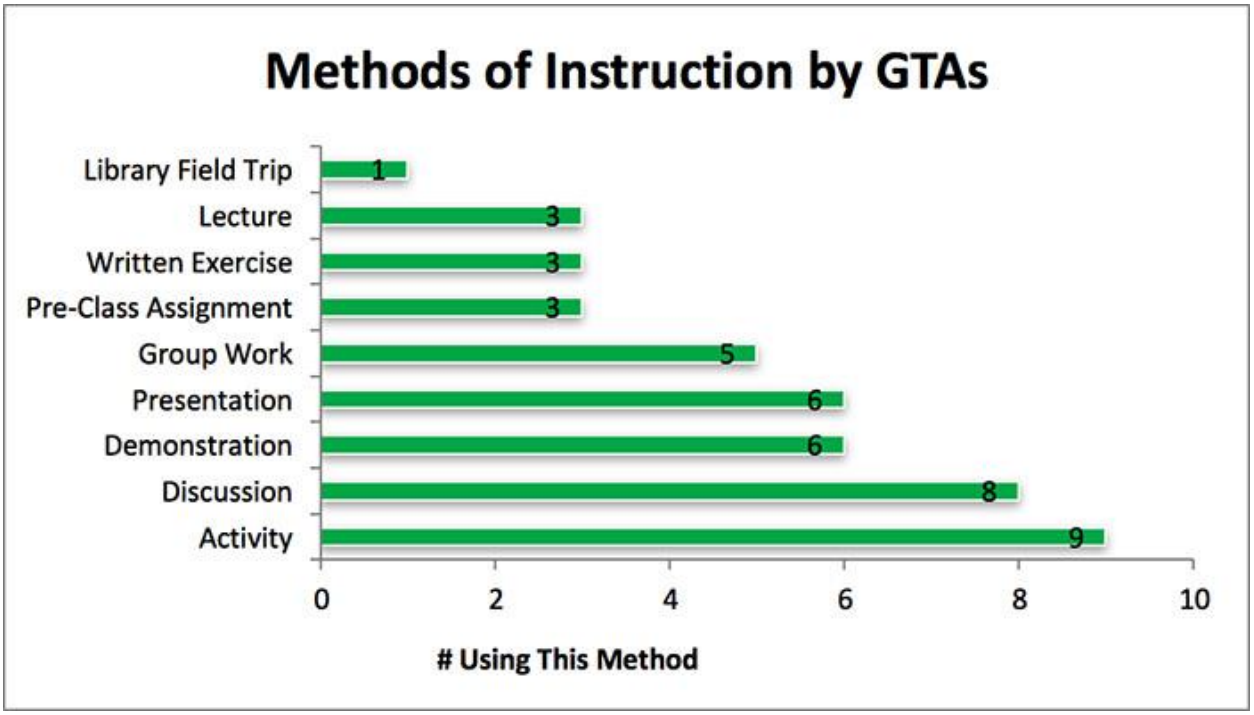
The interviews provide evidence of how information literacy skills are conveyed to and adopted by first-year science students. The primary finding is that GTAs employed limited teaching strategies to convey searching skills, using a small number of databases and teaching tools. There is little to no assessment performed by the GTAs and the undergraduate students did not convey confidence or even familiarity with science databases at the conclusion of the lab. While the GTAs are well versed in biological topics and comfortable with scientific literature, the interviewees revealed a lack of vocabulary about, and confidence with, database searching and other information retrieval skills.

The GTAs reported a wide range of experience as instructors for BIO 101, from one to seven semesters with two sections per semester. Four interviewees were teaching during the current semester. GTAs participating in this study taught a total of 50 lab sections of BIO 101 between 2008 and 2014.

Eight GTAs referred to the lab manual as a guide, required for students, that details the procedures of locating a specific research article. Additionally, GTAs mentioned handouts, the course syllabus, meetings and lists provided by the professor as additional tools used to teach the lab session.

GTAs varied their methods of teaching the lab session. Methods included lecture, demonstration, group work, discussion, activity, presentation, pre-class assignment, in-class written exercise and a library field trip. The most prevalent instruction technique was activity (database search), followed by discussion and then demonstration and presentation. The least employed method was the library field trip, which only one GTA employed (see Chart 1). Some GTAs employed multiple methods in the course of the lab. This range of methods reflects the

loose structure of the lab session; for the most part GTAs are free to deliver the material in whatever method or methods they choose.

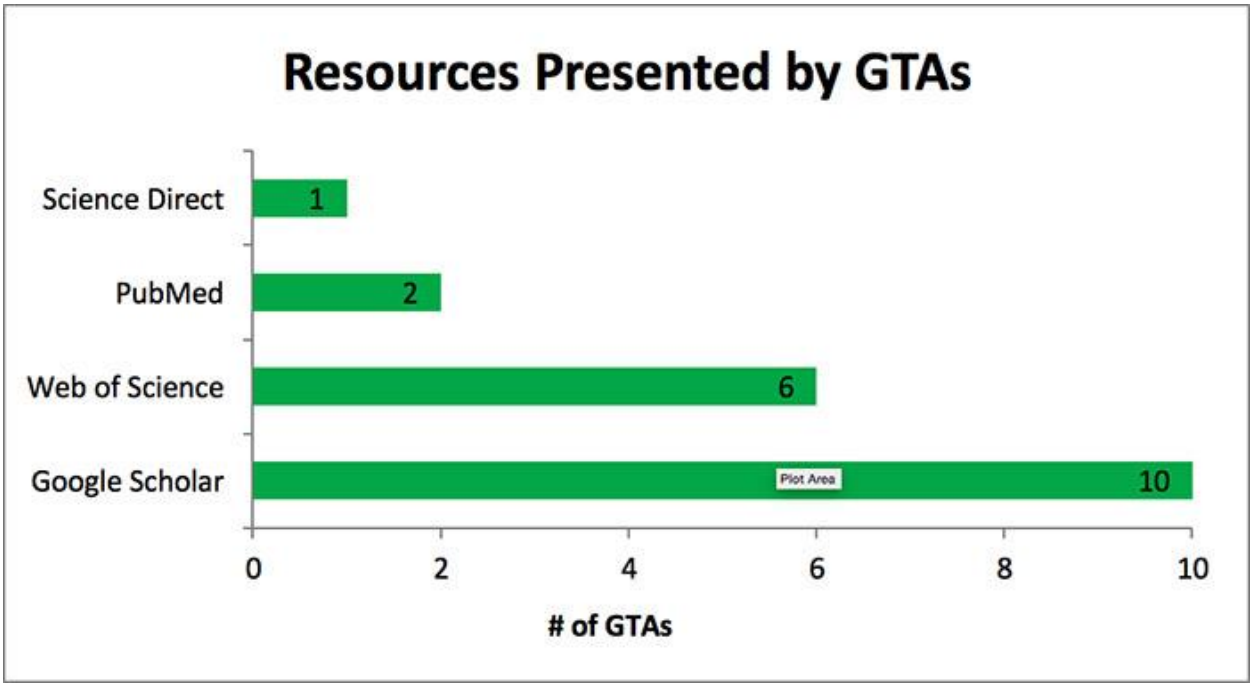


Each scientific literature lab session had the same basic outline, though objectives varied greatly by GTA. GTAs described the session as a narrative of concepts and activities. All ten mentioned searching for articles as an objective for this lesson. Half of the GTAs also included the concept of peer review, different types of articles including primary research and review articles, and the different components of scientific papers such as the abstract, methods, results, conclusion, etc. Seven GTAs discussed using at least two different databases for a search, but only two covered how to interpret the articles found. Other objectives mentioned only once but by various GTAs, included retrieving the article, the process of scientific publishing, citing sources, writing scientifically, citation rankings and presenting on the article.

Regarding pre-assessment, the GTAs rarely evaluated skills for finding and evaluating scientific literature before the lab section. Eight reported they did not pretest students. One had a pre-session evaluation and one informally questioned students before lab began. Five GTAs mentioned a pre-lab assignment that was used to encourage students to try searching for articles before class. Most of the post-instruction assessment was also informal. Seven of the

GTAs either graded assignments in class with the students or discussed results informally. One had students turn in the assignment for grading, and one reported there was no assessment at all. Of the ten GTAs interviewed, only three awarded participation points for discussion of this lab that counted towards students' final grade.

Though GTAs all followed the same basic outline, they used different databases to demonstrate examples and for students to search. All GTAs mentioned using Google Scholar either as the primary database for the searching exercise or a companion resource that students should consider using (see Chart 2). Though this class did not include health science research, two GTAs discussed it in the session because either they had health science backgrounds or because they believed that many of the students in BIO 101 would be participating in health science research.



GTA responses confirmed that few undergraduates, especially in the sciences, use the physical library (either print resources or spaces) for research purposes. Only one, who taught during one of the earliest semesters covered in the study (2008-09), actually sent students to the library to do research.

Student response to this lab also varied but was generally not positive. Six GTAs reported that students felt confused, bored, frustrated or responded with low enthusiasm. Only two GTAs reported that students reacted well to the assignment in that they did not find it difficult. One mentioned that students “appreciate the skills later on” when they complete the next assignment. Two did not remember or did not know how to describe student response. Regarding the perceived change of student skills after the session, three GTAs reported that students improved, four reported no change, two couldn’t tell as they were teaching their first semester, and one wasn’t sure. The largest point of consensus (9) was that students responded well to topics that interested them.

The GTAs themselves learned the concepts of science and information literacy in various ways. One GTA learned in a lab in a similar style to the lab class taught; two learned in the lecture hall; two took a specific course on scientific literature; two learned in the library or from a librarian; and three taught themselves. Seven of the GTAs learned how to search for and evaluate scientific literature in their second, third or fourth year of college. Two learned these skills in graduate school, and the final interviewee didn’t specify. Eight of the interviewees reported that searching for scientific literature is easier now than when they learned. One said it was harder and one said it was about the same.

When asked about the timing of the instruction in terms of the course semester, nine GTAs reported that the lab session occurred in the first couple weeks of the semester, while only one reported that the lab occurred in the middle or towards the end of the course. Nine GTAs also reported that the skills taught in this lab would be needed to complete future assignments in the class. However, of those nine, only three believed that these science literacy skills were necessary for undergraduates. Four GTAs felt that these skills were more appropriate for upper-level students; one said they should be taught in graduate school; and one wasn’t sure.

In each BIO 101 section GTAs are responsible for guiding students through the process of locating and evaluating published scientific research. The objectives of this lab session are similar to other science information literacy sessions delivered to first-year students at other institutions (Fuselier & Nelson 2011; Jacklin & Robinson 2013). The limited range of activities employed by most GTAs in the scientific literature lab is an indication that they lack experience in delivering information literacy instruction that covers a wide range of learning styles. Though

nine instructors did include an activity in the lab session, the activity referred to was a brief, single database search. GTAs often don't have the time or perhaps the resources to design lesson plans for these important skills. In a previous study using GTAs to teach science literacy topics with the guidance of a librarian, the GTAs reported difficulty in making connections between active learning techniques and the content to be covered, as well as difficulty keeping students engaged (Gregory 2013). By including more inquiry-based activities, GTAs could have more success with student learning outcomes while learning more about the research process themselves (French & Russell 2002). Librarians conversant in active learning exercises that encourage students to analyze and evaluate information could support GTAs by providing them with connections to interactive lesson plans that align with course objectives.

Just as in Spackman's focus group study, GTAs in this study reported that introductory level biology students were confused and frustrated by information literacy topics such as source evaluation and selection. However, they did not report students having trouble with the concept of peer review or finding full text articles as did the Spackman study. Spackman did not mention the topic of citation, or how students responded, whereas citation was one of the biggest challenges found in this study. The difference in challenges reflects the different final assignments in the two studies -- group presentation (current study) versus a poster presentation (Spackman) -- but both studies show that information literacy topics in the sciences are complex and not quickly learned. One session, even a session designed as a lab investigation, is not sufficient to cover all these skills or instill in students a pattern of successful searching behavior, but it could be enough to instill awareness and introduce one or two threshold concepts as discussed below.

To successfully educate students in finding and evaluating scientific information it is essential to address why those skills are valuable. Given that the general student response to the science literacy lab session was not positive and that this lack of interest has been reported in other studies (Gregory 2013), teachers of information literacy must not only cover the basic skills and strategies but also explain how those skills will help students in the current course, in future courses, and in their careers. Students cannot adequately grasp how much their work and study will revolve around research, because, as first-year students, they haven't yet experienced it. Students did respond positively to topics that interested them. For example, a GTA reported that a student who found articles on the latest cancer studies was excited because that student was already interested in cancer research. Teaching faculty, GTAs and librarians can capitalize on

this curiosity by seeking out student research interests and by connecting information literacy activities to the daily work done by practicing scientists. As Kuruppu and Gruber report, scholars highly value convenience, and librarians can make information literacy skills more appealing to GTAs and students by highlighting the efficiency of learning search strategies and database interfaces.

Conversations with GTAs on when and how they learned science literacy skills were problematic. They often proposed ideas that contradicted their own experiences. GTAs said that it is important to learn these skills early, but then they countered with the statement that students should not attempt these topics until they reach upper level classes. Teaching assistants in the Jacklin and Robinson study supported teaching information literacy skills in first-year courses because students have so little experience with them. Students themselves have reported a desire to have more information literacy skills taught in the first or second year (Jacklin & Robinson 2013). GTAs have also learned from their own experience, saying that these are important skills to be taught, but that they mostly were not taught directly and had to figure it out for themselves. Just as librarians are concerned about the efficacy of teaching information literacy when it isn't tied directly to a course assignment, GTAs saw little point in teaching these skills if they are not used in the class. While the majority reported that students will need to find research articles for future assignments in BIO 101, some thought that introductory science courses do not involve science literature and research as much as they should.

Just as the teaching assistants reported a wide range of student experience and results in the scientific literature lab, they themselves had varying backgrounds in information literacy instruction and relied on a limited number of resources in instruction. They were more familiar with open web resources such as Google Scholar than more focused subscription databases available through the library. One stated, "I only go to [campus resources] when there is something that I cannot find through Google Scholar." When asked about science databases, another said, "Even I don't know how to use them." They were also confused about the vocabulary, often referring to multiple or all databases and search tools as "the library database." Kuruppu and Gruber also found that graduate students "rarely use all, or even a wide variety of, the available relevant indexes to locate articles." GTAs struggled to describe specifically how and what information searching and evaluating topics they covered in classes. Although very comfortable talking about biological processes and even the scientific literature in

general, they were less sure of themselves when discussing the processes behind finding that literature. French and Russell showed that GTAs gain confidence in subjects through teaching them, specifically in inquiry-based activities, and this study confirms that they could benefit from more information literacy instruction themselves.

Assessment of information literacy skills can be difficult in any setting because it involves testing multi-step, critical thinking skills that are not easily measured. GTAs struggled with assessment -- not knowing what to assess, how to asses and what, if anything, students took away from the science literacy lab. This lack of assessment was an obstacle for both students and instructors. Untested, students remain unaware of what they do not know, sustaining the illusion that they do not need help regardless of their search abilities. Students also tend to overestimate their own abilities in working with scientific literature. Fuselier and Nelson found that even though students rated their own skills highly, they performed inadequately on written lab reports involving peer-reviewed articles. Without assessment, GTAs do not know when to provide more guidance and what concepts to cover in more depth. Luft, et al. also found that increased campus support may help GTAs improve their teaching abilities. This is another opportunity for librarians to connect GTAs with already existing pre- and post-assessment activities as a way of supporting the course curriculum.

Written lab reports are a common format used to assess students' understanding of concepts. Though there was no written lab assignment for the "How to Read a Scientific Paper" lab described in this study, students were expected to use articles and citations in subsequent lab reports. Student success on future assignments depended on their success on this introductory lab. GTAs were likewise motivated to encourage students to do well on this lab because they are responsible for grading lab reports. Lab sections themselves are often designed especially to engage early-career scientists in the process of evaluating and comparing previous research. GTAs are essentially teaching the research skills they will employ in their own careers as scientists, yet GTAs were not enthusiastic about this lab and the student response was even worse. Changing the perception of this lab from just one of the "easy labs" to the gateway lab that will lead to success on future labs could help students and GTAs connect better with the material.

Threshold concepts -- transformative leaps in understanding -- play as important a role in biology as they do in information literacy. They help illustrate the gaps between graduate

teaching assistants and the material they are covering. GTAs described briefly what was taught, and in some cases how it was taught, but they had little conception of how information literacy skills can be transformative. Before students can conduct experiments and communicate their findings as scientists they must be able to understand the scientific literature. For students to understand scientific literature, they must be able to find it and be secure in its validity. The first step to successful scientific communication is knowing where and how to search for scientific articles. GTAs are still developing these skills themselves and have not yet worked through all the challenges. Even when frustrated by unsuccessful searches, graduate students rarely ask for help because they believe they should already know what to do (Kuruppu & Gruber 2006). Librarians can encourage teaching assistants to recognize threshold concepts and to continue to develop their own understanding by adapting the Information Literacy Framework into practices that teaching assistants can use in specific lab exercises. Assessment activities that rate tasks accomplished but also reveal perceptions about scientific information and research articles will help GTAs reflect on their own understanding of information literacy concepts and develop their teaching practice.

Conclusion

Interviews with ten graduate teaching assistants responsible for teaching information literacy skills to students in a BIO 101 lab session illustrate the difficulty in conveying these complex skills. Information literacy is not an area of expertise among graduate biology students and many of them never formally learned the skills themselves. GTAs often do not receive database instruction as graduate students because they are expected to be familiar with them already (Kuruppu & Gruber 2006). GTAs do not have enough confidence in their own skills to design student-centered learning around these difficult concepts. They themselves are still in the process of transforming from students to instructors and researchers. They recognize the need for students to acquire skills in finding and evaluating scientific literature, but disagree on the best point at which to teach them. Librarians understand that just-in-time instruction and instruction tied to a specific assignment and the larger course curriculum are vital to increase student acquisition and retention of these skills. The implication of this research leads in two possible directions: librarians must provide direct support for GTAs or the library must collaborate with faculty to train them.

One possible way to increase the GTAs' awareness and depth of understanding of library resources is a train-the-trainer type of program, where librarians work with teaching assistants

to plan instruction. GTAs are recognized by students both as authorities and as peers and as Hartman, et al. point out, students know GTAs have power over grades. Students acknowledge the benefit of discussing concepts with teaching assistants in their classes (Jacklin & Robinson 2013). GTAs are perfectly poised to influence students by sharing their own search practices and techniques.

An alternative model to provide support both for GTAs and students is online tutorials, preferably designed by librarians in cooperation with GTAs and teaching faculty. Tutorials can address different skills such as citation, searching databases, and article evaluation while building a foundation of best practices. Online activities are often more popular with students than paper-based workbooks, and therefore more utilized, simply because of the technology aspect (Jacklin & Robinson 2013). Interactive tutorials can also encourage students to explore databases and academic articles by asking open-ended questions. Both graduate and undergraduate students support the concept of online instruction in database at the point-of-need (Kuruppu & Gruber 2006; Jacklin & Robinson 2013). Tutorials can be revisited at different points in the semester, providing just-in-time instruction for both students and GTAs.

Further research on how GTAs learn and convey information literacy skills is needed. Future studies should investigate what resources or delivery methods would be best received by GTAs for reviewing these concepts. This study did not address how the students fared in future class assignments using the skills covered in the lab section on scientific literature or how students retained those skills over time – that is another focus for further analysis.

Scholarly publications are the key mechanism by which scientists communicate their research with the science community and the world. Before students can master scientific writing they must successfully read and understand scientific articles, and before they can read articles they need to be able to find them. Lab classes, which serve to connect lecture with research and experimentation by collaborative learning, are an excellent place to experience inquiry-based activities that develop information literacy skills. Information literacy skills set the foundation for scientific communication, and science librarians should continue to explore how to teach those skills effectively to undergraduate and graduate students alike.

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Appendix: Interview Questions

Introduction:
How many semesters have you taught BIO 101?
Typically how many sections do you teach BIO 101?

Description of instruction:
At which point in the semester do you teach the lab on finding research?
Does the professor provide you with an outline of which resources to teach?
Tell me how you designed the lab assignment, or where did it come from?
Describe how you teach students to do research?

Resources:
What specific tools do you teach?
Follow ups: which databases, searching by journal title, ILIAD, using the book catalog, keyword search strategies?

Student Response:
How do students respond to this lab?
Is there an attached assignment?
Do students ask follow up questions?
Do you notice a difference in student's work after the lab?
How do you measure student success on this assignment? Are there specific outcomes you look for?

Background:
Tell me the process of how you learned bio search skills as an undergraduate? What kind of changes have you seen in how students search? In what ways it is easier or harder for students now versus when you learned?

Follow up:
Can you refer me to other grad students in BIO or other departments that teach this type of science research?
May I contact you via email if I have any follow up questions for you?