What Did They Say and Why Did They Say It?:

Scholarship as Conversation in the Science Classroom

Robert Correll
Sciences Librarian
North Dakota State University

Beth Twomey
Head, Research & Instruction
North Dakota State University

ACRL Information Literacy Frame: Scholarship as Conversation
Discipline: Science & Engineering
Subject: Natural Sciences
Learning Theory: Constructivism
Special Populations: Undergraduate Students

A professor teaching an upper-division biology course approached one of the authors about helping students identify appropriate sources for assignments. Traditionally, undergraduate science courses have been textbook-based along with formulaic labs designed to achieve a predetermined result. Increasingly, however, undergraduate science programs are attempting to expose upper-division undergraduates to more authentic research methods, including introducing them to the working scientific literature, especially to primary research articles.[1] Faculty members in multiple

departments have indicated that their upper-division students do not have the skills to differentiate between primary and secondary sources and so are choosing inappropriate sources for assignments. Students instead rely on a very basic metric—that they found the article in a scholarly journal without regard for the nature or purpose of the source. By focusing on the purpose of the various sources in the sciences, students should be able to distinguish between different types of articles and appreciate the role and interactions between them in the broader scholarly conversation. This naturally leads to a discussion of citations as they are one of the primary ways that relationships between sources are made apparent, as well as a discussion of plagiarism because of the ways in which it distorts those relationships.

ACRL Information Literacy Frame: Scholarship as Conversation

Reflecting on the relationships between various scientific publications led us to the *ACRL Framework for Information Literacy*, specifically the frame, Scholarship as Conversation. A few knowledge practices stood out as being particularly relevant to what faculty wanted their students to grasp:

- Identify the contribution that particular articles, books, and other scholarly pieces make to disciplinary knowledge.
- Recognize that a given scholarly work may not represent the only or even the majority perspective on the issue.
- Cite the contributing work of others in their own information production.[2]

The following lesson was designed to help students independently identify original research articles (i.e., primary sources) in the sciences and to recognize the important role that citation plays in tracing the genesis and evolution of scientific research.

Learning Theory: Constructivism

We chose to use a constructivist approach to designing the lesson both because it was a good fit for the more complex tasks asked of upper-division science students and because it aligned with the increased focus on active learning and reformed pedagogy at our institution. In the constructivist approach, the student is at the center: "It assumes that learning can only

take place when students are actively engaging with the topic and 'constructing' their own knowledge bases."[3] Three necessary aspects must be present in order for successful learning within the constructivist paradigm: concept (knowledge), culture (context), and activity (practice).[4] Learning becomes an act of building new mental models "within the framework of the learner's prior knowledge and experience."[5] A mental model can be understood as a schema which represents a learner's understanding of a system or process which was formed through interaction with that system or process.[6] In addition, learning does not occur in isolation and is always mediated by a student's social interactions with others; it also needs to be situated in authentic experiences and environments. Finally, students must have the opportunity to actively apply new mental models to authentic tasks. The role of the instructor is to provide appropriate tasks and situations for students to test and apply new mental models and to provide substantive feedback to guide the student's development.[7]

As we began planning for the lesson, we made the assumption that upper-division science students had most likely been exposed to the idea of primary and secondary sources through their humanities general education courses. This prior knowledge gave students the foundation we needed to use a constructivist approach in the lesson. Primary sources in the humanities include artifacts and documents created at the time or place being studied, while in the sciences a primary source is an original research article reporting a new experiment, theory, or result. This prior exposure still creates a natural launching point for students to construct new understandings based on their pre-existing knowledge and experiences and expand them into the sciences.

Lesson Description

Inspired by the framework, we felt that introducing original research and review articles as parts of a scholarly conversation would guide students toward a deeper understanding of the differences between primary and secondary sources in the natural sciences. As our lesson planning progressed, we discussed how citations could be seen as the ways those conversations are made explicit and, further, how plagiarism can distort and obstruct our ability to perceive those relationships. In particular, we wanted students to see how original research ultimately gets aggregated and summarized in review articles as part of the process of moving the scientific conversation

forward and how, in turn, original research situates itself in the discipline by citing the work it is based on. Grounding ourselves in constructivism, we chose to expose students to three articles from the scientific literature that were representative of the types of sources they would encounter during a search in a database while doing research for their class assignment. The articles that we chose were connected by citations; one was an original research article, one a review article, and the third a commentary on the original research article.

At the beginning of the class, we primed the students for the lesson by asking them to review definitions of primary and secondary sources in the humanities versus the sciences that were posted to their course learning management system (LMS) before the class session. We used an in-class review of those definitions as a way to orient students to the rest of the lesson.

Students were then asked to gather in small groups and analyze the articles in light of the definition of primary sources in the sciences with which they had been provided and to determine if the articles were primary or secondary sources. We asked student groups to be prepared to explain to the class the reasons for their classification of each article. We then went through each document, giving students feedback about their answers and addressing any disagreements or misconceptions that arose. Finally, we turned the discussion toward the purpose of each article by asking students, what are the authors reporting, and why? In this way, the students were drawn into discussing the relationships between the articles and how they built on each other.

After discussing each article individually, we highlighted the citations connecting the articles and used them to bring in the metaphor of "conversation" directly. We pointed out that each article was building on the ones that came before it: if scholarship is a conversation, then the later articles are responding directly to the ones they cite. We discussed examples of how each article builds on the cited literature, such as using methods or discussing findings and questions from earlier papers. The citation allows future readers (who may become authors themselves) to backtrack to find those earlier papers and discover more information about the topic, as well as discover any flaws in earlier papers that might affect the results of the current paper.

Talking about citations can lead to a productive conversation about plagiarism. When discussing how articles connect with each other through

citations, we pose the question of how plagiarism affects these connections. By keeping the concept of plagiarism grounded in the concept of the scholarly conversation, students may be able to construct a more coherent understanding of plagiarism and citation. To reinforce this message, a simple formative assessment may be used, as described below.

We followed this lesson with an opportunity for students to practice their new mental models about primary resources in the sciences by using an assessment which required them to identify a new-to-them article as primary or secondary and to identify three characteristics of the article that supported their contention. After collecting the assessment, in accordance with constructivist principles, we reviewed the article and took the opportunity to correct any misconceptions.

One of the dispositions associated with the Scholarship as Conversation frame is that students who are learning will "recognize they are often entering into an ongoing scholarly conversation and not a finished conversation."[8] While not one of our learning objectives, we hope that by showing students how researchers conduct their discourses by looking at citation chains, students are guided toward an appreciation that individual researchers and the artifacts of their research, whether primary or secondary, do not exist in isolation but in conversation with their peers and prior work.

Lesson Plan

Learner Analysis

This lesson is intended for upper-division, undergraduate students in biological sciences but it could easily be adapted to other STEM disciplines. These students previously have had limited exposure to the scientific research process and are at a point in their undergraduate education where they are ready to begin engaging with the professional literature more directly. According to their instructors, many upper-division students have more confidence in their ability to choose appropriate resources than is borne out by the evidence. Moreover, students are close to graduating and will soon be leaving the university for jobs or for further education. Within the various STEM disciplines, whether in academia or in a professional position, students will need to be able to identify primary literature in the discipline.

Orienting Context and Prerequisites

Through their class LMS

- students will each read one set of scholarly articles posted by the instructor, and
- students will each read a short description of primary and secondary sources in the sciences.

Instructional Context

- The optimal environment for this lesson is an in-person session in a room that facilitates group work. An instructor computer, projector, and screen are needed with the requisite software (PowerPoint or equivalent). Optimal class size is fewer than twenty-five students, as our experience has shown that larger groups are less conducive to the discussion parts of the lesson. To get ready for the instruction session, the librarian needs to select appropriate articles to post in the LMS, including a review article, an original research article, and at least one other type of literature found in scholarly journals, such as invited comments, letters to the editor, etc.
- For the class session itself, handouts need to be prepared consisting of condensed versions of each of the articles that were previously made available on the course LMS. These condensed versions should retain the various section headings as well as representative portions of the text. The aim is to provide enough information to allow the students to quickly identify the role and purpose of the article without being distracted by the whole text. The entire abstract and enough of the introduction should be retained so that students have sufficient information to determine whether they are primary or secondary sources. It is also important to include a few relevant sections of text demonstrating reliance on prior work, such as references to standard methods or comparisons with prior results. One page, front-and-back, should be sufficient for each article. Enough handouts should be prepared for each group of students to receive a copy of each article.
- A description and definition of primary and secondary resources in the natural sciences and how they differ from the humanities should be prepared and posted in the LMS along with the articles.

For the assessment, select and condense an article that students will evaluate to determine whether it is a primary or secondary source.

Learning Outcomes and Learning Activities

Learning Outcomes

Students will be able to

1. distinguish between primary and secondary research articles in the sciences (essential) and
2. explain how plagiarism distorts and disrupts the scholarly conversation (optional).

Learning Activities

1. Primary and Secondary Sources *(LO1, 20–30 minutes, essential)*

During this activity, students work in groups to identify whether a given article is primary or secondary and then report their reasoning to the class.

- The instructor reviews definitions of primary and secondary sources in the sciences.
- Students get into groups of three, and each group should have a copy of every condensed article.
- Students examine the articles and discuss whether they are primary or secondary sources.
- The instructor asks each group to report their findings and justify their decisions.
- The instructor guides a discussion that may include topics such as citations, the structure of research articles, currency, and the ways in which fields of knowledge evolve over time as evidenced by the literature review.

2. Plagiarism *(LO2, 10 minutes, optional)*

If the instructor wants to delve deeper into the function of citation in the sciences and the implications of improper citations or plagiarism, this activity provides an opportunity for students to discuss and evaluate examples of correct and incorrect paraphrasing and use of citations.

- Students review a paragraph from an article, which is accompanied by its correct citation.
- The instructor provides examples of various ways the source

paragraph could be cited or paraphrased by other scientists. Examples should include both correct and incorrect ways of citing and paraphrasing.
- Students indicate whether they think the citation is correct or incorrect, and the instructor invites students to explain their reasoning.

Assessment

We designed this instructional session to help students select appropriate sources for their assignments in the class. Our primary learning outcome was that students would be able to identify whether a given article in the sciences was either a primary or secondary source. We chose to develop an authentic assessment that is easy to execute. At the end of the session, students were provided with a new article that they had not seen before. This article was condensed in the same way as the previous articles. The students were instructed to answer two questions and write their responses directly on the article. They were asked first whether the article was primary or secondary and, second, to either write down or circle and label on the article three characteristics of the article in support of their decision. After collecting the assessment, we reviewed the article with the class, clarifying its classification and any misconceptions that arose during the review. In alignment with constructivist principles, we provided immediate feedback to support student development of new and correct mental models. Success in the assessment would include the students correctly identifying whether the article was primary or secondary and providing valid justification for their choice. It is possible that a student would just guess, so the supporting evidence is required to determine if the student has mastered the task or not. For example, a student could claim a resource was a secondary source but identify the results section of the article as proof, indicating they did not actually grasp the concept.

Our optional learning outcome involved plagiarism. We wanted students to be able to recognize that plagiarism is not just an academic infraction and something they can get in trouble for, but a practice with deeper implications for scholarship as a whole. Likewise, citations are not just arbitrary tasks but in fact perform a vital service in guiding researchers through the scholarship of their discipline. We developed an in-class activity where we showed a paragraph from an article and asked students

to imagine that they wanted to use information from that paragraph in a paper. We then showed them various sentences that paraphrased the information in the paragraph along with a citation. Some of the sentences were improperly cited, others were poorly paraphrased in such a way that they would be deemed plagiarism, and some sentences were correctly cited and paraphrased. Students were asked to consider each example and raise their hands if they thought it was plagiarized. Volunteers were then asked to explain their reasoning, which often led to lively discussions. This activity was assessed formatively, with the instructors observing students' responses and providing additional feedback or correction when necessary. Success for this assessment meant a majority of the students correctly identified whether the sentence was plagiarism or not.

Notes

1. Carol A. Brewer and Diane Smith, eds., *Vision and Change in Undergraduate Biology Education: A Call to Action* (Washington, DC: American Association for the Advancement of Science, 2011), 21, http://visionandchange.org/files/2011/03/Revised-Vision-and-Change-Final-Report.pdf.
2. Association of College and Research Libraries, *Framework for Information Literacy for Higher Education* (Chicago: Association of College and Research Libraries, 2015), 8, http://www.ala.org/acrl/sites/ala.org.acrl/files/content/issues/infolit/Framework_ILHE.pdf.
3. R. Todd Hartle, Sandhya Baviskar, and Rosemary Smith, "A Field Guide to Constructivism in the College Science Classroom: Four Essential Criteria and a Guide to Their Usage," *Bioscene* 38 no. 2 (2012): 32.
4. John Seely Brown, Allan Collins, and Paul Duguid, "Situated Cognition and the Culture of Learning," *Educational Researcher* 18, no. 1 (1989): 32–42.
5. Peter E. Doolittle, "Complex Constructivism: A Theoretical Model of Complexity and Cognition, *International Journal of Teaching and Learning in Higher Education* 26, no. 3 (2014): 489.
6. Donald A. Norman, "Some Observations on Mental Models," in Mental Models, ed. Dedre Gentner and Albert L. Stevens (New Jersey: Lawrence Erlbaum Associates, 1983): 7–14.
7. Hartle, Baviskar, and Smith, "Field Guide to Constructivism," 43–71.
8. Association of College and Research Libraries, *Framework*, 8.

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