



The Ecology of Information Literacy: Modes of Inquiry, Location, and Assessment in a Biology Department's Writing Class

Harrison Carpenter

Department of Ecology & Evolutionary Biology
University of Colorado

Barbara Losoff

Associate Professor, Life Science Librarian
University of Colorado

Rebecca Kuglitsch

Head, L.H. Gemmill Engineering, Mathematics & Physics Library
University of Colorado

ACRL Information Literacy Frame: Scholarship as Conversation

Discipline: Science & Engineering

Subject: Life Sciences

Learning Theory: Student-Centered Sociocultural Learning

Special Populations: Undergraduate Students

Like many universities, the University of Colorado Boulder's (CU's) curriculum contains capstone courses enabling undergraduate students to develop skills in employing written communication in post-graduation, professional work. Frequently, capstones focus on writing genres within certain disciplines. Such is the case for one writing class housed within

CU's Department of Ecology and Evolutionary Biology (EBIO 3940: Written Communication in the Sciences). The class adheres with curricular priorities EBIO formulated in response to calls for enhanced STEM learning.¹ Building upon the department's priorities, faculty teaching EBIO 3940 aim for students to move beyond mere grammatical and stylistic correctness into a critical understanding of writing's purposes within STEM.

To build that awareness, many learning activities have been designed to teach students how to extract information from peer-reviewed research reports and critically assess its accuracy, authority, and breadth. However, too few of EBIO 3940's students were showing prowess in such skills, despite information literacy (IL) sessions. Students were able to perform searches competently, but we noted that they lacked the ability to apply deeper analyses. As noted by Feekery and Emerson, the class was operating under the premise that IL skills and writing skills were largely independent; we were teaching IL as a series of procedures, rather than as concepts deeply enmeshed within writing and reasoning.² Farrell and Badke similarly call "to position IL as [an] integral part of disciplinary socialization."³ We saw a need to act toward integrating IL within the students' STEM education and to guide them toward enculturation in their disciplines.⁴ Once socialized into disciplinary practices in the sciences, "good writers will clearly and concisely convey information, support their statements with data, incorporate credible outside sources as needed, and properly cite information from outside sources."⁵ When planning sessions for EBIO 3940, we redesigned our instruction to give students opportunities to participate in scholarly conversations so they can join the community of scientists.

ACRL Information Literacy Frame: Scholarship as Conversation

To improve IL skills, we sought to synthesize EBIO 3940's writing assignments with library instruction, especially to build students' IL by positioning them to critically assess information in peer-reviewed science journal articles. When we began fleshing out plans, we found the Framework for Success in Post-Secondary Writing by the Council of Writing Program Administrators (CWPA) underscores habits of mind critical to college success.⁶ These habits of mind (including engagement, curiosity, flexibility, and metacognition) parallel dispositions and knowledge practices found

in ACRL's *Framework for Information Literacy for Higher Education*,⁷ and align with calls made by librarians before it was developed.⁸ ACRL's framework presents a "cluster of interconnected core concepts, with flexible options for implementation,"⁹ supporting both a procedural and conceptual focus of IL instruction. Thus, it can create opportunities for librarians to partner with writing faculty in order to engage students in critically and reflectively locating, evaluating, analyzing, interpreting, using, and assessing information.

In our case, we focused on the frame Scholarship as Conversation because we felt it afforded an opportunity for students to recognize how scholars engage in information exchange through composition, publication, reading, analysis, and critique of written communication. Framing Scholarship as Conversation acknowledges questions of vocabulary, sentence and paragraph composition, genre, and other norms of written communication within a discipline while aligning with IL skills necessary to evaluate sources and select contextually appropriate ones. Examining CWPA's habits of mind, we find similarities between the frame and the conditions CWPA identifies as fostering the habit of mind of engagement—for example, "mak[ing] connections between their own ideas and those of others; find[ing] meanings new to them or build[ing] on existing meanings as a result of new connections; and act[ing] upon the new knowledge that they have discovered."¹⁰ Among factors contributing to students' learning, CWPA identifies developing knowledge of writing conventions, developing critical thought processes through research, reading and writing, and developing rhetorical savvy as contributing to habits of mind. Both CWPA's and ACRL's frameworks are in tune with the skill sets underpinning EBIO's STEM learning goals.

Learning Theory: Student-Centered Sociocultural Learning

Sparked by those connections, we constructed a series of single-day, research-centered learning activities based on advancements found in studies of sociocultural learning theory in which learning activities are essentially located in social spheres.

In class sessions, students explore the spheres in what Vygotsky termed a "zone of proximal development" (ZPD). To Vygotsky, ZPD is "the dis-

tance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving ...in collaboration with more capable peers.”¹¹ In our framework, ZPDs constitute the social spheres through which students are guided in our classroom. In such avenues, learning results from collaborative engagement. By framing a ZPD, educators can provide an active learning environment in which students interact with their peers and their teachers to reach their highest levels of learning.¹² We applied this in the classroom in two ways: students exploring as peers within a ZPD and engaging in learning activities as legitimate peripheral participants in the community of scientists.¹³

Although an established framework for learning, sociocultural theory has been of nascent interest to those developing IL learning activities and lesson plans,¹⁴ despite the interest in student-centered learning.¹⁵ In short, applications of “sociocultural theories [are] still new in IL research.”¹⁶ We surmised that interactive, experiential learning activities could enable students to build an interactive social sphere in which their IL learning would be enhanced.¹⁷ We aimed to plan lessons that guide students through a series of IL learning activities coherent with STEM education but which also provide opportunities to interact in a social sphere.

Best and Worst-Case Teaching Scenarios

The best-case scenario for applying this lesson plan is one where students have familiarity with the norms of a discipline and its primary literature. When students are just learning to decode scientific writing, the cognitive burden of simply understanding the content may be high enough to make it impossible to also analyze how citations are used and how authors deploy factual data. Consequently, we suggest using a paper that students have already read for class, rather than a wholly new paper. This ensures that students are able to explore in a ZPD. Because the session was redesigned collaboratively by librarians and EBIO 3940’s instructor, we identified a representative, discipline-specific paper from the course readings. We suggest librarians teaching this lesson work with course faculty to identify such a paper. Because students are already familiar with the article’s structure, content, argumentative flow, and syntax, they have the cognitive space for in-depth analysis of the ways that scientists exchange information through writing.

Our approach to dissecting conventions of citation and evidence works especially well in the context of a STEM class focused on writing. The mindset of dissecting rhetorical norms aligns well with understanding Scholarship as Conversation and exploring how authors might choose to engage in a conversation by contributing to the scientific literature. In the activities within such a class, students are prepared to engage the implicit and explicit rules of evidence and citation within majors. A grasp of how authors critique concepts, present data, or seek to conceal gaps using rhetorical strategies inherent to a discipline's genres, can prepare students to see that authors might choose to use evidence and citations in similar ways.

Another key factor for this plan's success is time. Students need time to discuss content in groups and to share their insights with all their classmates, librarians, and instructors. In situations where there are significant time constraints, or when other essential skills must be taught in a single class period, some content might need to be assigned ahead of time. Students could be assigned to read and analyze the paper before the library session; we would suggest assigning the reading and conducting the analysis approximately a week before the library session so students have time to absorb but not forget the article's content and structure.

Teaching and Learning Goals

Our lesson plan situates students' inquiry in a scholarly conversation. Our overall goal is for students to learn how scientists build research programs in response to each other by critically analyzing each other's studies. This is a key step in one's enculturation into a community of scientists.¹⁸ However, it can be challenging for students accustomed to fact-oriented textbooks to understand how apparently solid facts are developed from lively disputes, tentative conclusions, and active conversations. Grasping how numerous viable responses may be given to research questions is a challenge. Our second goal is aiding students' in recognizing and understanding an array of perspectives within scientists' conversations. Meeting both goals dovetails nicely with IL instruction (which opens questions of authority and accessing the scientific conversation) and writing instruction (which opens discussion of socially derived writing conventions).

Lesson Plan

Learner Analysis

Our lesson plan is designed for upper-division (third and fourth year) undergraduate science majors, primarily within life sciences. Although the lesson offers students within the life sciences opportunities for incorporating IL into writing within the discipline, it is generalizable to suit to the learning styles and priorities of undergraduates majoring in any of the sciences.

Orienting Context and Prerequisites

- We suggest this activity for students who have junior or senior standing and who have successfully completed a lower-division writing course.
- Students should have read the article to be analyzed before their initial library session, either in class or as homework.

Instructional Context

- Optimal classroom setup facilitates small group discussion and engagement, such as tables seating four or five students, or chairs that can be easily moved into small groups.
- Before instruction, handouts should be printed or posted on a collaborative space such as a course management system, and students should be provided with either digital or print copies of the article.
- One large whiteboard or several large sticky notes (one for each section of the article) are needed to record student discussion and presentation.

Learning Outcomes and Learning Activities

Learning Outcomes

1. Students are able to perform critical inquiry and critical reading by drawing connections and making comparisons between the results of studies reported in articles they locate in searches. Through these reading strategies, they are able to identify how studies may be driven by research questions aligned with solv-

ing a broader, contextual problem, may either curtail or inspire further research, or may be used as grounds for refining methodologies.

2. Students are able to construct a question that enables them to begin to enter the scholarly conversation of their discipline in order to guide their inquiry (investigating, sifting, and categorizing the resources they find).
3. Students are able to critically assess the information derived from scholarly journal articles in order to identify gaps in the literature and to pinpoint questions that remain to be answered.

Learning Activities

1. Reading Strategies (*LO1, 40–45 minutes, essential*)
 - Students are introduced to reading strategies that stimulate critical thinking. Provide students with an exemplary journal article, separate them into groups of four or five students, and direct each group to look closely at one article section (Introduction, Methods, Results, or Discussion). It is better to have student groups of this size, even if this means some sections may have more than one group examining them. Each group receives a handout listing a series of questions for the article sections (see Appendix 40A), written to prompt careful reading and a critical assessment of the study's use of citations as well as rigor, quality, and significance. Allot five minutes for explaining the activity, fifteen to twenty minutes for small group discussion, and twenty minutes for small groups to report their findings to the whole class.
2. Identifying Research Questions (*LO2, 20–25 minutes, optional*)
 - Students read the assigned article and identify the author's research question. Later, they will use that question as a model to develop their own research questions. In a subsequent library session, they come to class with their questions which they will seek to answer by reviewing the literature. Use their questions as vehicles for teaching them how to use technically precise keywords in their literature searches, and ask them to refine their searches by noting repeated keywords seen in

sources' records. By doing so, students are given opportunities to undertake their inquiry in a manner more in tune with a reviewer's line of reasoning. Students also install and begin to use Zotero, an open source bibliographic management tool, to organize their sources.

3. Refining Research Questions (*LO3, 20–25 minutes, essential*)
 - Students investigate their questions in a librarian- and faculty-supported search session. Students read through sources and identify questions, and librarians and faculty circulate to work with students one-on-one at sticking points and help refine and reframe questions.

Assessment

Assessment Goals

Assess students' degrees of success in understanding the scholarly conversation surrounding the assigned article and their eventual research topic, as well as their success in practicing legitimate peripheral participation within those conversations.

Assessment Tools

Our assessments are primarily qualitative. To assess outcomes of the learning activities, we have found students' writing—in particular, their literature reviews—can give indications of their IL skills. Seeking, acquiring, and understanding information sources when composing a literature review is a challenge. To help us assess students' success, we first assign them a brief, reflective one-minute paper, delivered between our sessions (Appendix 40B), to informally glimpse into their process of learning. A summative assessment of formally applied learning is indicated in composed literature reviews; we read and assess their content following a rubric (Appendix 40C).

How Success is Measured

Using the one-minute paper and rubric, success is measured qualitatively. The one-minute paper measures students' success in identifying the most important thing they learned, which should match our learning objectives. It also allows us to identify muddy areas, correct misconceptions, and address areas of confusion in further class sessions.

A directed reading of literature reviews tells of students' successful application of our learning objectives. Using the rubric allows for assessment of students' success, since it allows for measuring four discursive elements: (1) synthesis (incorporating different kinds of information to reflect an overall understanding); (2) comparison and contrast (analysis and critique of information to determine its authority and accuracy); (3) hypothesis (conclusions drawn in response to questions of inquiry); and (4) call to action (expressing new questions and positing future research agendas, suggestive of entry into scholarly conversation).

Appendix 40A

The Handout to Guide Discussion of Primary Literature

EBIO 3940 Written Communication in the Sciences

Primary Literature Worksheet

Read the assigned section of this article:

Ryan TJ, Peterman W, Stephens JD, Sterrett SC. 2014. Movement and habitat use of the snapping turtle in an urban landscape. *Urban Ecosystems* 17:613-623.

Within your group formulate answers to the assigned questions.

Introduction:

- What is the research question addressed in this study?
- Select a citation. What information have the authors noted as coming from someone other than themselves? Why do you think the authors chose to do so? In what way could that choice help the authors lead to the research question?
- Select a reference or citation and explain how that reference informs the authors' premise.

Methods:

- What assumptions did the authors seem to make in order to justify their methods?
- How many citations are in the section? What is the information the authors noted as coming from someone other than themselves?

Results:

- Was the research question you identified adequately addressed? If so, how was the question answered? If not, what was missing in order to answer the question?
- How can the results help readers (other scientists) to understand and/or evaluate the methods?
- In what ways are the results presented? How do you think those

choices could affect readers' interpretation of the results' significance, the study's quality, and/or the authors' expertise?

Discussion:

- Select a citation. Explain why the authors used this reference in the section.
- What are the next studies/experiments the authors call for? Which do you think should come first, and why? What is most realistic as a next step?
- What do the authors identify as the most important result? How did they arrive at that conclusion? Do you agree or disagree? Why?
- Do you have any questions for the authors? Formulate those questions into criticisms. What wasn't addressed in the discussion?

Appendix 40B

One-Minute Paper Assignment

EBIO 3940: Library session assessment

Let me know what you learned, what worked, and what didn't so we can improve this session in the future. We'll address questions that remain unclear on Wednesday!

What is the most important thing you learned in these two library sessions?

What remains unclear after these three library sessions?

Is there anything else you'd like to let us know about these sessions?

Submit

Never submit passwords through Google Forms.

Appendix 40C

Summative Rubric for Assessing Students' IL Proficiency in Writing Literature Reviews

Measures of IL Proficiency			
Information Use	<i>Strongly Proficient</i>	<i>Moderately Proficient</i>	<i>Minimally Proficient</i>
<i>Contextualizing Information (Introduction)</i>	Describes a research area of disciplinary interest. Recognizes broader disciplinary conversation and effectively/clearly connects their research to it. Articulates social context of the research.	Defines a research area of disciplinary interest. Acknowledges broader disciplinary conversation and attempts to connect their research to it. Mentions social context of the research.	Names a research area of disciplinary interest. No recognition of broader disciplinary conversation and/or no articulated connection to the broader conversation. Does not acknowledge social context for the research.
<i>Summary and Synthesis (Body)</i>	Draws topical similarities and coherent relationships between articles cited. Makes logical connections between individual articles.	Draws topical similarities between articles cited, and suggests relationships between them. Connects individual articles, although not always in a logical manner.	Draws little or no topical similarities or relationships between articles cited. Makes superficial/illogical connections between articles.
<i>Cohesion (Conclusion)</i>	Constructs logical conclusions from critical reading of articles cited. Insights are clearly stated and take into account stated interests of other researchers. Postulates future research based on gaps identified from the cited articles.	Proposes conclusions from critical reading of articles cited with minimum logical flaws. Takes into account stated interests of other researchers. Postulates future research but does not provide solid reasoning for such suggestions.	Refers back to articles cited. Weakly logical. Does not take into account stated interests of other researchers. Suggests future research but ideas are either minor or are presented in an unclear or illogical way.

<i>Representation of Sources (Reference)</i>	Compelling, relevant evidence derived from legitimate sources. Referenced sources are primarily peer-reviewed journal articles; exceptions have a clear disciplinary rationale. Understands that information, concepts, and/or theories are legitimate within the discipline.	An adequate amount of evidence derived from sources. Many referenced sources are peer-reviewed journal articles; disciplinary rationale is fairly unclear. Indicates some information, concepts, and/or theories are legitimate, not necessarily within the discipline.	Minimal evidence derived from sources, or presented evidence is unrelated to sources. Few referenced sources are peer-reviewed journal articles; disciplinary rationale is unclear. Gives no indication that information, concepts, and/or theories are legitimate within a discipline.
<i>Documentation of Sources (Citation and Bibliography)</i>	Sources are documented such that they can be easily found. Discipline-appropriate bibliographic style is used without error. Recognizes and understands the purposes of documenting sources.	Sources are documented such that moderate effort is required to locate them. Discipline-appropriate bibliographic style is used with minimal error. Acknowledges the purposes of documenting sources.	Sources are documented such that considerable effort is required to locate them. Discipline-appropriate bibliographic style is used with substantial error, or chosen style is inappropriate in the discipline. Recognizes the use of documentation within the classroom.

Notes

- Norris A. Armstrong, Carolyn S. Wallace, and Shu-Mei Chang, "Learning from Writing in College Biology," *Research in Science Education* 38, no. 4 (2008): 483–99, doi:10.1007/s11165-007-9062-9; Julie A. Reynolds et al., "Writing-to-Learn in Undergraduate Science Education: A Community-Based, Conceptually Driven Approach," *CBE Life Sciences Education* 11, no. 1 (2012): 17–25, doi:10.1187/cbe.11-08-0064.
- Angela Feekery and Lisa Emerson, "Embedding Information Literacy and Writing Development into the Disciplines," *TEXT* 21 (2013): 1–16.
- Robert Farrell and William Badke, "Situating Information Literacy in the Disciplines: A Practical and Systematic Approach for Academic Librarians," *Reference Services Review* 43, no. 2 (2015): 334, doi:10.1108/RSR-11-2014-0052.
- Brian Winterman, Carrie Donovan, and Rachel Slough, "Information Literacy in Multiple Disciplines: Toward a Campus-Wide Integration Model at Indiana University, Bloomington," *Communications in Information Literacy* 5, no. 1 (2011): 38–54.

5. Leigh Thompson and Lisa Ann Blankinship, "Teaching Information Literacy Skills to Sophomore-Level Biology Majors," *Journal of Microbiology & Biology Education* 16, no. 1 (2015): 29, doi:10.1128/jmbe.v16i1.818.
6. Council of Writing Program Administrators, National Council of Teachers of English, and National Writing Project, "Framework for Success in Postsecondary Writing," 2011.
7. Association of College & Research Libraries (ACRL), *Framework for Information Literacy for Higher Education*, 2015, <http://www.ala.org/acrl/standards/ilframework>.
8. Donna Mazziotti and Teresa Gretano, "'Hanging Together': Collaboration Between Information Literacy and Writing Programs Based on the ACRL Standards and the WPA Outcomes," in *Declaration of Interdependence: The Proceedings of the ACRL 2011 Conference*, March, 2011, 180–90, http://www.ala.org/acrl/sites/ala.org/files/content/conferences/confsandpreconfsnational/2011/papers/hanging_together.pdf.
9. ACRL, *Framework*.
10. Council of Writing Program Administrators, National Council of Teachers of English, and National Writing Project, "Framework for Success in Postsecondary Writing," 2011.
11. L. S. Vygotsky, *Mind in Society: The Development of Higher Psychological Processes*, ed. Michael Cole et al., revised edition (Cambridge, Mass.: Harvard University Press, 1978).
12. Vera John-Steiner and Holbrook Mahn, "Sociocultural Approaches to Learning and Development: A Vygotskian Framework," *Educational Psychologist* 31, no. 3–4 (1996): 191–206, doi:10.1080/00461520.1996.9653266.
13. Jean Lave and Etienne Wenger, *Situated Learning: Legitimate Peripheral Participation* (Cambridge: Cambridge University Press, 1991).
14. Li Wang, Christine Bruce, and Hilary Hughes, "Sociocultural Theories and Their Application in Information Literacy Research and Education," *Australian Academic & Research Libraries* 42, no. 4 (2011): 296–308, doi:10.1080/00048623.2011.10722242.
15. Susan M. Land, Michael J. Hannafin, and Kevin Oliver, "Student-Centered Learning Environments: Foundations, Assumptions and Design," in *Theoretical Foundations of Learning Environments*, ed. David Jonassen and Susan Land (Routledge, 2012), 3–26.
16. Wang, Bruce, and Hughes, "Sociocultural Theories and Their Application in Information Literacy Research and Education," 297.
17. Brian Detlor et al., "Student Perceptions of Information Literacy Instruction: The Importance of Active Learning," *Education for Information* 29, no. 2 (2012): 147–61, doi:10.3233/EFI-2012-0924.
18. Michael Carter, "Ways of Knowing, Doing, and Writing in the Disciplines," *College Composition and Communication*, (2007): 385–418.

Bibliography

- Association of College and Research Libraries [ACRL]. *Framework for Information Literacy for Higher Education*. Last modified January 11, 2016. <http://www.ala.org/acrl/standards/ilframework>.
- Armstrong, Norris A., Carolyn S. Wallace, and Shu-Mei Chang. "Learning from Writing in College Biology." *Research on Science Education* 38 (2008): 483–99.
- Carter, Michael. "Ways of Knowing, Doing and Writing in the Disciplines." *College Composition and Communication* 58 (2007): 385–418.
- Council of Writing Program Administrators [CWPA]. "Framework for Success in Postsecondary Writing." Last modified January 2011. <http://wpacouncil.org/framework>.
- Detlor, Brian, Lorne Booker, Alexander Serenko, and Heidi Julien. "Student Perceptions of Information Literacy Instruction: The Importance of Active Learning." *Education for Information* 29 (2012): 147–61.
- Farrell, Robert, and William Badke. "Situating Information Literacy in the Disciplines: A Practical and Systematic Approach for Academic Librarians." *References Services Review* 43 (2015): 319–40.

- Feekery, Angela, and Lisa Emerson. "Embedding Information Literacy and Writing Development into the Disciplines." *TEXT* 21 (2013): 1–16.
- John-Steiner, Vera, and Holbrook Mahn. "Sociocultural Approaches to Learning and Development: A Vygotskian Framework." *Educational Psychology* 31 (1996): 191–206.
- Land, Susan M., Michael J. Hannafin, and Kevin Oliver. "Student-Centered Learning Environments: Foundations, Assumptions and Design," in *Theoretical Foundations of Learning Environments*, edited by David Jonassen and Susan M. Land, 3–26. New York: Routledge, 2012.
- Lave, Jean, and Etienne Wenger. *Situated Learning: Legitimate Peripheral Participation*. New York: Cambridge UP, 1991.
- Mazziotti, Donna, and Teresa Grettano. "Hanging Together: Collaboration Between Information Literacy and Writing Programs Based on the ACRL Standards and the WPA Outcomes," in *Declaration of Interdependence: The Proceedings of the ACRL 2011 Conference*, March, 2011, 180–90. http://www.ala.org/acrl/sites/ala.org.acrl/files/content/conferences/confsandpreconfsnational/2011/papers/hanging_together.pdf.
- Reynolds, Julie A., Christopher Thaiss, Wendy Katkin, and Robert Thompson, Jr. "Writing-to-Learn in Undergraduate Science Education: A Community-based, Conceptually Driven Approach." *Science Life Education* 11 (2012): 15–25.
- Thompson, Leigh, and Lisa Ann Blankenship. "Teaching Information Literacy Skills to Sophomore-Level Biology Majors." *Journal of Microbiology & Biology Education* 16 (2015): 29–33.
- Wang, Li, Christine Bruce, and Hillary Hughes. "Sociocultural Theories and Their Application in Information Literacy Research and Education." *Australian Academic Research & Research Libraries* 42 (2011): 296–308.
- Winterman, Brian, Carrie Donovan, and Rachel Slough. "Information Literacy for Multiple Disciplines." *Communications in Information Literacy* 5 (2011): 38–54.
- Vygotsky, L. S. *Mind in Society: The Development of Higher Psychological Processes*, edited by Michael Cole et al., revised edition. Cambridge, MA: Harvard UP, 1978.
- Yardley, Sarah, Pim W. Teunissen, and Tim Dornan. "Experiential Learning: Transforming Theory into Practice." *Medical Teacher* 34 (2012): 161–64.