Joining the Conversation: Teaching Students to Think and Communicate Like Scholars

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Author Note

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Abstract

Although today's psychology students are well versed in the early stages of the scientific method (developing a research question, designing an experiment), they are rarely asked to engage in the final stage of the scientific method: building and communicating an idea among scholars. As a result, students often fail to appreciate the "unending conversation" that is academic inquiry. To help students learn to think like scientists and join a scholarly conversation, educators have tried mirroring elements of scholarly practices in the classroom (e.g., writing, collaboration). Evidence in the natural sciences has suggested that each of these pedagogical techniques, taken individually, can enhance students' critical thinking. More recent work in chemistry education, however, has demonstrated that a holistic approach, engaging students in multiple scholarly practices, may lead to greater gains in critical thinking. In this article, I argue for such an approach in psychology—one that more closely mirrors how scholars operate in the real world. As a model, I present a scaffolded writing project that asks students to think like scientists by engaging in multiple scholarly practices: collaborative writing, inquiry-based research, and peer review. I hypothesize that students can make significant gains in critical thinking when they are placed in the role of scholar. I thus call for a new direction in how we approach today's psychology students and highlight the critical need for empirical testing of this and other combinatory approaches.

Keywords: collaborative writing, peer review, critical thinking, scholarly conversation, literature review

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> Build on a foundation of science. (American Psychological Association, 2020, "Guiding Principles" section)

Across undergraduate psychology curriculums, students are taught to explore human behavior through the scientific method. They are often asked to form research questions, design studies, and interpret the resulting data. Less commonly, however, are students taught the final step of the scientific method: building and communicating an idea among scholars (Hogan & Fisherkeller, 2005).

As a result, students often fail to appreciate the ongoing exchange of ideas that occurs between scholars (Goodney & Long, 2007), what rhetorician Kenneth Burke described as the "unending conversation" (Burke, 1941, pp. 110–111). For scholars in psychology, this conversation might manifest directly via peer review or coauthoring or more indirectly through the framing of data within the context of others' texts and theories (Harris, 2017). Across these cases, psychologists build their work—their theories, experiments, and interpretations—by engaging with other scholars and their ideas.

This engagement structures how we, as psychological scientists, think. Most students, however, have a limited understanding of how scientists interact to build knowledge over time (Hunter et al., 2007). In my experience, we do not give our students enough time or space to struggle through the scientific process, as scientists do. At best, we might ask students to engage in a single scholarly practice (e.g., write an academic piece, pose a question, or work in groups). Indeed, some empirical research in the natural sciences has demonstrated that each of these pedagogical techniques—writing, inquiry-based research, collaboration—can enhance students' critical thinking (Quitadamo & Kurtz, 2007).

For example, Quitadamo and Kurtz (2007) found that students who participated in a laboratory writing component in an introductory biology course significantly improved their inference and analysis skills compared with students who completed more traditional laboratory quizzes. Hein (2012) found that students who learned organic chemistry through an inquiry-based approach scored significantly

higher on nationally standardized chemistry exams compared with students who learned through lectures. Finally, Quitadamo et al. (2009) demonstrated gains in critical thinking across six math and science courses for students participating in collaborative learning compared with a noncollaborative approach (Quitadamo et al., 2009). These studies provide empirical evidence that writing, inquiry-based research, and collaboration are all techniques that can enhance student learning. How these techniques can be used together in a more holistic approach is less understood.

Recent work in chemistry education has indicated that more holistic approaches may better mimic how scientists operate in the real world (Stephenson et al., 2019; Stephenson & Sadler-McKnight, 2016). Stephenson et al. (2019) found that students in introductory chemistry who were taught via an approach that combined writing, inquiry-based research, and collaboration showed significant gains in two empirical measures of critical thinking—inference and evaluation—unlike students taught through traditional lectures. Stephenson et al. hypothesized that the large gains in critical thinking reflect a synergistic effect resulting from the combinatory approach.

In this article, I argue for a similar approach in psychology—one that combines multiple scholarly practices and thus better mirrors how scientists operate in the real world. As an example, I present a scaffolded writing project in which I asked students to write collaboratively, conduct inquiry-based research, and engage in peer review across the writing process. In this way, students could learn to appreciate and join a scholarly conversation. I hypothesize that combinatory approaches, like the one presented here, can help students make significant gains in critical thinking.

Why Writing?

Writing offers one of the most effective ways for making thinking visible (Reynolds et al., 2012) and, when applied to disciplinary questions, helps students learn to think like disciplinary experts (Bean, 2011; Dowd et al., 2018; Meizlish et al., 2013). The act of writing is a form of problem-solving (Flower, 1998) that, like critical thinking, requires the coordination of many skills, including planning,

organization, and argumentation (Dunn & Smith, 2008). Writing can help students identify areas of confusion, reason through problems, connect concepts, and analyze assumptions (Dunn et al., 2013; Forsyth, 2003). As a practice, writing is ideally suited to foster critical thinking that mirrors that of disciplinary experts (Dowd et al., 2018; Meizlish et al., 2013; Reynolds et al., 2012).

Collaborative writing, in particular, can help foster scholarly modes of thinking and communication. It creates a community of learners who provide cognitive and social support beyond that available to an individual working alone (Brown & Campione, 1996). In collaboration, students can better organize their thoughts and identify gaps in their own reasoning (Okita, 2012; Speck, 2002) as well as evaluate the evidence and assumptions underlying their claims (Stephenson & Sadler-McKnight, 2016). These modes of thinking are especially important when students are asked to develop their own questions and subsequent responses.

Collaboration is critically important not only when an idea is initially developed but also when an idea is molded and refined through peer review. Like writing, peer review can benefit students' thinking (Lundstrom & Baker, 2009; Matsuhashi et al., 1989). By seeing others' logical missteps, students can learn to identify an argument's gaps or organizational inconsistencies (Beach, 1989; Ferris, 2003; Thompson, 2002) and to analyze ideas from perspectives beyond their own (Paulus, 1999). As a result, students who engage in peer review tend to revise their own work more extensively, produce stronger texts, and better understand the scientific process (Brieger & Bromley, 2014; Guilford, 2001; Lee, 1997; Rangachari, 2010; Rollinson, 2005; Trautmann, 2009). Some empirical evidence has suggested that even web-based peer-review programs can improve students' learning, but only when they are designed to address higher-order writing concerns (Reynolds & Moskovitz, 2008). Thus, it seems the greatest gains come when we challenge students to look beyond editing concerns and address the kinds of questions that scientists ask of their own work.

In sum, by engaging in scholarly conversation—through collaborative writing, inquiry-based

research, and peer review—students can learn to think like scientists. These practices, in combination, form the basis for the pedagogical model presented here.

A Writing-Centered Approach

My approach asks students to take on the role of scholar—to build and communicate an idea within a community of peers. It centers on a sequenced writing project in which student pairs cowrite a literature review on a topic of their choice. The goal of the project is to develop a novel claim by forwarding previous research. This requires students to first frame their ideas within the context of existing scholarly work and to then collaborate with peers as they develop their argument and give and receive feedback. The project is heavily scaffolded using a combination of pedagogical techniques, some of which have been shown individually to enhance student learning (Hein, 2012; Quitadamo et al., 2009; Quitadamo & Kurtz, 2007), whereas others are in need of empirical testing (e.g., synthesis matrices, annotations responses, dialogue activities).

Course Design

The project was assigned to 1st-year students as part of an introductory, seminar-style writing course at Duke University (12 students per course). The course was open to all 1st-year students regardless of their intended major (at Duke, majors are not officially declared until the fourth semester of enrollment). The course was offered as one of many Writing 101 sections, each taught through a different disciplinary lens based on the expertise of the professor. As a cognitive psychologist and neuroscientist by training, I centered my course on neurolaw, an emerging field that explores how discoveries in brain science affect the U.S. justice system. For the project I propose here, students explored any topic at the intersection of psychology and law (upon my approval). However, the project could be applied in many different fields of study.

The project unfolded over several stages, each framed within the scholarly conversation and designed to help students build critical-thinking and communication skills. Students produced several

assignments, including a proposal, annotated bibliography and responses, synthesis matrix, and three drafts. Although students wrote most of the assignments outside of class, I often provided class time for collaborative work, check-in meetings, and peer review. In this way, students were in continuous dialogue with their partners and peers across the writing process. Next, I list the project stages (for a visual depiction, see Figure 1).

Stages of the Writing Project

Stage 1: How Do Scholars Communicate? Set the Stage

At the start of the project, I introduced scientific thinking as a conversation, reminding students that they are scholars capable of contributing to academic dialogue. We discussed how scientists build their work by engaging with other scholars and their ideas. To practice these interactions (both socially and across texts), students cowrote a court brief, using neuroscientific evidence to appeal the sentence of a real court case (*Graham v. Florida*, 2010).

Stage 2: What Conversation Should I Join? Find a Topic and a Partner

Students self-selected a partner based on shared interests, identified on a set day of class. On that day, each student presented a 2-min speech pitching a line of research. Students then participated in a speed-dating activity (Muurlink & Poyatos Matas, 2011), with the goal of finding a partner and a topic. Typically, pairs formed organically, although oftentimes students compromised to select what academic conversation they would join. Once pairs formed, I met with each team in class to approve their topic and brainstorm ideas. For example, we might discuss what specific gap in knowledge they wanted to fill or how to narrow the scope of their topic. Across these interactions, students practiced how to brainstorm ideas with peers, similar to scientists at professional conferences.

Stage 3: How Will We Collaborate as a Team of Scholars? Build a Plan for Collaboration

After completing a class team-building activity and reviewing the Peer Evaluation Form, partners created a collaboration contract that detailed how they would work together. Students set goals and

established the principles through which the pair would operate. I encouraged teams to set weekly meetings, emphasizing that those who meet both regularly and in person tend to produce the strongest papers. Creating the collaboration contract helps students practice good work habits that professional scientists use when interacting with colleagues (e.g., regular lab meetings).

Stage 4: What Are Scholars Discussing, and What Could We Add? Explore the Literature and Develop a Research Question

Over several weeks, partners explored the literature and refined their topic into a research question (RQ; e.g., To what extent should the legal system apply neuroprediction to assess reoffense in juveniles?). First, we met with a librarian to discuss how to find and evaluate academic sources. Next, we analyzed model texts, emphasizing the qualities of a good RQ and the ways in which scientists use previous literature to build their work. Students then drafted an RQ, which we workshopped during an in-class gallery walk (Francek, n.d.).

Stage 5: What Is Each Scholarly Voice Adding to the Conversation? Organize Previous Literature and Analyze Model Literature Reviews

As coauthors developed their RQ, they continued to explore the literature outside of class. For each source, students wrote an annotation, summarizing what a text claimed and how it fit into their own work. Next, students began to connect the texts more directly, writing annotation responses that analyzed how one reading relates to another. This written "discussion" between sources ensured that partners read the same texts. It also created space for students to evaluate the quality of a source and its relation to the RQ. At this stage, we also examined model academic literature reviews in class, highlighting rhetorical "moves" scholars make when forwarding or countering an idea. This analysis gives students a model for how to frame their own arguments.

Stage 6: How Can We Join the Dialogue? Develop a Novel Argument

Coauthors created a *synthesis matrix* (Clark & Buckley, 2017), a chart that visually arranges

sources around a series of claims that, when put together, build the students' argument. Each column of the matrix represents a source and each row a claim. Thus, a row as a whole represents the synthesis of sources that build a given claim. The row could contain both confirmatory and counterevidence that students put together to build a claim and potentially address a counterargument (e.g., Although X argues…, we support Y's theory because…). In sum, each cell in a row summarizes what a source adds to the row's claim. And the claims together, row by row, represent the logical unfolding of the students' overall argument. In my experience, the synthesis matrix is pivotal in helping students organize their ideas around the work of other scholars. It helps students mimic the thought processes that professional scientists use when writing a literature review.

Stage 7: Join the Conversation: Draft, Revise, and Reflect

From the synthesis matrix, coauthors developed their literature review over three drafts that underwent multiple stages of revision. As students prepared to draft, I again emphasized that writing is a dialogue between scholars' ideas. In class, we practiced building a scholarly conversation using a dialogue activity where students wrote a playlike script between sources. We then translated the verbal dialogue into a written one. In a follow-up activity called "mapping the conversation" (Pittock, 2014), students arranged pieces of evidence (written on sticky notes) to create a visual representation of an academic paragraph, which they then used to write an actual paragraph. Like the synthesis matrix, this activity helps students learn to put texts in conversation.

Once Draft 1 was complete, students reviewed each other's work extensively. First, I discussed with students how to give meaningful, constructive feedback. Next, we conducted a large-group workshop where students, in a structured setting, practiced giving feedback that focused on higher order writing concerns. Once students felt more confident in their peer-review skills, they engaged in small-group workshops that focused on various higher-order writing concerns (e.g., for peer-review handouts). Across these workshops, students practiced multiple forms of peer review: verbal, like that

between coauthors, and written, like that between authors and reviewers or editors.

Students submitted their final draft, along with letters reflecting on their writing process, on the last day of class. Papers were evaluated based on the criteria detailed in the prompt using a holistic rubric developed by faculty in Duke's Thompson Writing Program.

Outcomes

Student Reactions

Across five course sections (*N* = 57; three surveys incomplete), end-of-semester evaluations suggested that the project helped students learn to think and communicate like academic scholars. When asked about the collaborative writing process specifically, more than 90% of students "agreed" or "strongly agreed" that collaborative writing, compared with writing on their own, helped them better learn to (a) analyze others' arguments and ideas, (b) express their own ideas more clearly, (c) synthesize scholarly research, and (d) give more meaningful feedback to peers. In all cases, the majority of students "strongly agreed." When asked about the course more generally, all students agreed that the course helped them learn to think and communicate like academic scholars.

Students also reflected on their collaborative writing experience in an open-ended writing response. In the Appendix, I list excerpts from those reflections, highlighting three trends I observed in students' growth. First, students developed critical-thinking skills necessary to join the scholarly conversation. They discussed learning how to analyze sources, identify knowledge gaps, and link sources together. Second, through collaborative writing and peer review, students gained new perspectives on their own thinking and writing. Students said they were better able to consider others' perspectives and to identify gaps in logic. And third, students became more confident in their writing and began to view themselves as scholarly writers. Students shared an increased willingness to seek out feedback from others, which helped them find their "voice" and feel more confident about their writing.

On the basis of these student reports, I hypothesize that the project can help students make

gains in many areas, including enhancing critical thinking, synthesizing ideas across sources, communicating clearly and effectively, improving collaboration with peers, and learning how to give meaningful and constructive feedback. These hypotheses are in need of testing and serve as a foundation for future empirical research.

Discussion

The model presented here asks students to engage in multiple scholarly practices—collaborative writing, inquiry-based research, and peer review—and thus mirrors how scientists operate in the real world. The approach centers on a coauthored literature review that unfolds over several stages (see Figure 1), each framed within the context of the scholarly conversation and designed to help students build critical-thinking and communication skills.

The project could serve as a model for other psychology courses. The literature review is a ubiquitous piece of writing in psychology, and faculty could tailor the project to address their course topic. Of note, the project is particularly well suited for small, seminar-style courses where faculty can serve as guides and foster a supportive community of scholars. It might be particularly useful for seminars on scholarship in psychology or on thesis writing.

When considering a collaborative approach, faculty should evaluate several additional factors. First, faculty should consider whether they have the time to prepare the project stages (e.g., organize a library workshop, plan peer-review sessions, structure activities). In my experience, I needed extensive time to scaffold the project initially; however, once structures were in place, I devoted most of my energy to helping students learn to think through their own ideas. Second, faculty must be willing to use class time flexibly so that students can brainstorm ideas, collaborate with their partner, and share feedback. And finally, faculty must be willing to prioritize skill development—to let students grapple with the collaborative writing process.

Next Steps

A significant challenge in psychology education is how to teach students to think and communicate critically. A second challenge is how to confirm that our teaching methods are indeed meeting this aim. Although critical thinking is a difficult construct to define and quantify (Stephenson et al., 2019), researchers have developed some standardized measures. One popular assessment tool is the California Critical Thinking Skills Test, which defines critical thinking as a synthesis of higher order cognitive skills, including analysis, inference, evaluation, induction, and deduction (Panettieri, 2015; Quitadamo & Kurtz, 2007). The test has been evaluated for validity and reliability in measuring critical thinking at the collegiate level (Facione, 1990), and it may therefore be an appropriate instrument for evaluating pedagogical approaches like my own.

Conclusion

In sum, I call for a new direction in psychology education—one that centers students in scholarly conversation and practice. To this end, I present a holistic approach that engages students in collaborative writing, inquiry-based research, and peer review. I hypothesize that by embracing the role of scholar, through the combination of these practices, students can grow as critical thinkers and communicators. Future research must test this hypothesis, evaluating the effectiveness of this and other combinatory approaches.

References

Allin, T., & Meyer, B. (2021). *PUBPOL 850: Using human-centered design.* Duke University Bass Connections. https://bassconnections.duke.edu/using-human-centered-design

American Psychological Association. (2020). *American Psychological Association strategic plan*. https://www.apa.org/about/apa/strategic-plan

Beach, R. (1986). Showing students how to assess: Demonstrating techniques for response in the writing conference. *College Composition and Communication*, *37*(1), 56–65. https://doi.org/10.2307/357382

Bean, J. C. (2011). *Engaging ideas: The professor's guide to integrating writing, critical thinking, and active learning in the classroom* (2nd ed.). Jossey-Bass.

Brieger, K., & Bromley, P. (2014). A model for facilitating peer review in the STEM disciplines: A case study of peer review workshops supporting student writing in introductory biology courses. *Double Helix*, *2*, 1–10. https://wac.colostate.edu/docs/double-helix/v2/brieger.pdf

Brown, A. L., & Campione, J. C. (1996). Guided discovery in a community of learners. In K. McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 229–270). The MIT Press.

Burke, K. (1941). *The philosophy of literary form: Studies in symbolic action* (3rd ed.). University of California Press.

Clark, K. R., & Buckley, M. B. (2017). Using a synthesis matrix to plan a literature review. *Radiologic Technology*, *88*(3), 354–357. http://www.radiologictechnology.org/content/88/3/354.extract

Dowd, J. E., Thompson, R. J., Schiff, L. A., & Reynolds, J. A. (2018). Understanding the complex relationship between critical thinking and science reasoning among undergraduate thesis writers. *CBE—Life Sciences Education*, *17*(4), 1–10. https://doi.org/10.1187/cbe.17-03-0052

Dunn, D. S., Saville, B. K., Baker, S. C., & Marek, P. (2013). Evidence-based teaching: Tools and techniques that promote learning in the psychology classroom. *Australian Journal of Psychology*, *65*(1), 5–13. https://doi.org/10.1111/ajpy.12004

Dunn, D. S., & Smith, R. A. (2008). Writing as critical thinking. In D. S. Dunn, J. S. Halonen, & R. A. Smith (Eds.), *Teaching critical thinking in psychology: A handbook of best practices* (pp. 163–173). Blackwell Publishing. https://doi.org/10.1002/9781444305173.ch14

Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction*. California Academic Press.

Ferris, D. R. (2003). *Response to student writing: Implications for second language students*. Routledge. https://doi.org/10.4324/9781410607201

Flower, L. (1998). *Problem-solving strategies for writing in college and community*. Harcourt Brace College Publishers.

Forsyth, D. R. (2003). *The professor's guide to teaching: Psychological principles and practices*. American Psychological Association.

Francek, M. (n.d.). *Gallery walk*. Science Education Resource Center at Carleton College. https://serc.carleton.edu/sp/library/gallerywalk//index.html

Goodney, D. E., & Long, C. S. (2007). *Composing dialogues for critical thinking* (EJ824637). ERIC. https://eric.ed.gov/?id=EJ824637

Graham v. Florida, 560 U.S. 48 (2010). https://supreme.justia.com/cases/federal/us/560/48/

Guilford, W. H. (2001). Teaching peer review and the process of scientific writing. *Advances in Physiology Education*, *25*(3), 167–175. https://doi.org/10.1152/advances.2001.25.3.167

Harris, J. (2017). *Rewriting: How to do things with texts* (2nd ed.). Utah State University Press. https://doi.org/10.7330/9781607326878

Hein, S. M. (2012). Positive impacts using POGIL in organic chemistry. *Journal of Chemical Education*, *89*(7), 860–864. https://doi.org/10.1021/ed100217v

Hogan, K., & Fisherkeller, J. (2005). Dialogue as data: Assessing students' scientific reasoning with interactive protocols. In J. J. Mintzes, J. H. Wandersee, & J. D. Novak (Eds.), *Assessing science understanding: A human constructivist view* (pp. 95–127). Academic Press. https://doi.org/10.1016/B978-012498365-6/50007-X

Hunter, A.-B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education*, *91*(1), 36–74. https://doi.org/10.1002/sce.20173

Lee, I. (1997). Peer reviews in a Hong Kong tertiary classroom. *TESL Canada Journal*, *15*(1), 58–69. https://doi.org/10.18806/tesl.v15i1.692

Lundstrom, K., & Baker, W. (2009). To give is better than to receive: The benefits of peer review to the reviewer's own writing. *Journal of Second Language Writing*, *18*(1), 30–43. https://doi.org/10.1016/j.jslw.2008.06.002

Matsuhashi, A., Gillam, A., & Moss, B. (1989). A theoretical framework for studying peer tutoring as response. In C. M. Anson (Ed.), *Writing and response: Theory, practice, and research* (pp. 293–316). National Council of Teachers of English.

Meizlish, D., LaVaque-Manty, D., Silver, N., & Kaplan, M. (2013). Think like/write like. In R. J. Thompson (Ed.), *Changing the conversation about higher education* (pp. 53–74). Rowman & Littlefield Education.

Muurlink, O., & Poyatos Matas, C. (2011). From romance to rocket science: Speed dating in higher education. *Higher Education Research & Development*, *30*(6), 751–764. https://doi.org/10.1080/07294360.2010.539597

Okita, S. (2012). Social interactions and learning. In N. M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 3104–3107). Springer. https://doi.org/10.1007/978-1-4419-1428-6_1770

Panettieri, R. C. (2015). Can critical-thinking skills be taught? *Radiologic Technology*, *86*(6), 686–688. http://www.radiologictechnology.org/content/86/6/686.extract

Paulus, T. M. (1999). The effect of peer and teacher feedback on student writing. *Journal of Second Language Writing*, *8*(3), 265–289. https://doi.org/10.1016/S1060-3743(99)80117-9

Pittock, S. P. (2014). *Mapping the conversation*. Stanford University. https://web.archive.org/web/20191213181611/https://teachingcommons.stanford.edu/teachingwriting/teaching-talk/mapping-conversation

Quitadamo, I. J., Brahler, C. J., & Crouch, G. J. (2009). Peer-led team learning: A prospective method for increasing critical thinking in undergraduate science courses. *Science Educator*, *18*(1), 29–39.

Quitadamo, I. J., & Kurtz, M. J. (2007). Learning to improve: Using writing to increase critical thinking performance in general education biology. *CBE—Life Sciences Education*, *6*(2), 140–154. https://doi.org/10.1187/cbe.06-11-0203

Rangachari, P. K. (2010). Teaching undergraduates the process of peer review: Learning by doing. *Advances in Physiology Education*, *34*(3), 137–144. https://doi.org/10.1152/advan.00071.2009

Reynolds, J., & Moskovitz, C. (2008). Calibrated peer review assignments in science courses: Are they designed to promote critical thinking and writing skills? *Journal of College Science Teaching*, *38*(2), 60–66.

Reynolds, J. A., Thaiss, C., Katkin, W., & Thompson, R. J., Jr. (2012). Writing-to-learn in undergraduate science education: A community-based, conceptually driven approach. *CBE—Life Sciences Education*, *11*(1), 17–25. https://doi.org/10.1187/cbe.11-08-0064

Rollinson, P. (2005). Using peer feedback in the ESL writing class. *ELT Journal*, *59*(1), 23–30. https://doi.org/10.1093/elt/cci003

Speck, B. W. (2002). *Facilitating students' collaborative writing: ASHE-ERIC higher education report: Jossey-Bass higher and adult education series*. Jossey-Bass.

Stephenson, N. S., Miller, I. R., & Sadler-McKnight, N. P. (2019). Impact of peer-led team learning and the science writing and workshop template on the critical thinking skills of first-year chemistry students. *Journal of Chemical Education*, *96*(5), 841–849. https://doi.org/10.1021/acs.jchemed.8b00836

Stephenson, N. S., & Sadler-McKnight, N. P. (2016). Developing critical thinking skills using the science writing heuristic in the chemistry laboratory. *Chemistry Education Research and Practice*, *17*(1), 72–79. https://doi.org/10.1039/C5RP00102A

Thompson, C. (2002). Teaching critical thinking in EAP courses in Australia. *TESOL Journal*, *11*(4), 15–20. https://doi.org/10.1002/j.1949-3533.2002.tb00104.x

Trautmann, N. M. (2009). Interactive learning through web-mediated peer review of student science reports. *Educational Technology Research and Development*, *57*, 685–704. https://doi.org/10.1007/s11423-007-9077-y

Figure 1

Stages of the Project Sequence

	DISCOVER			DEVELOP			DELIVER			
	BRAINSTORM		PLAN	SYNTHESIZE			DRAFT	REVISE		REFLECT
Stage	1	2	3	4	5	6	7			
Framing	How do scholars communicate?	What conversation should I join?	How will we collaborate as a team of scholars?	What are scholars discussing? What could we add?	What is each scholarly voice adding to the conversation?	How can we join that dialogue?	Join the conversation			
Goals	Introduce scientific thinking as a conversation	Identify topic & partner	Build collaboration plan	Explore the literature Develop RQ	Analyze model texts Organize previous literature	Develop a novel argument	Draft literature review	Peer Review Revise	Peer Review Revise	Reflect on Process
Activities	Case Study: A Teen Offender	Speed Dating Activity	Team-Building Activity	Library Workshop RQ Gallery-Walk	"Moves" of a Literature Review Workshop		Dialogue Activity Sticky-Note Activity	Large Group Workshop Peer Review	Small-Group Workshops Peer Review	Class Discussion
Assignments	Court Brief	Elevator Speech	Collaboration Contract	Initial RQ	Annotation & Annotation Responses	Synthesis Matrix Revised RQ	Draft 1		Draft 2	Final Draft Reflection Letter

Note. Each stage was framed around the scholarly conversation and designed to help students build critical thinking and communication skills. RQ = research question. Adapted from *PUBPOL 850: Using Human-Centered Design*, by T. Allin and B. Meyer, 2021, Duke University Bass Connections (https://bassconnections.duke.edu/using-human-centered-design). Copyright 2020 by Duke University.

Appendix

Student Testimonies Highlight Three Aspects of Growth

Students Developed Critical-Thinking Skills That Allowed Them to Enter the Scholarly Conversation

- **Comment 1:** "Thinking critically about the strengths and limitations of the sources in the annotated bibliographies and creating the synthesis matrix gave me a greater understanding of each source and how they fit together in conversation. Before this semester, I'd often view my evidence in isolation, like ropes falling from a central claim. But I've learned now that stronger papers synthesize evidence, weaving sources together in a net that more substantially supports the central claim."
- **Comment 2:** "I have learned how to use sources in a way that makes the authors of each piece collaborate."
- **Comment 3:** "Through activities performed in class such as using different color notes and arrows to link author's arguments, I can now think through complex scientific studies, draw connections between sources, and identify gaps in knowledge my argument seeks to fill."

Through Collaborative Writing, Students Gained New Perspectives on Their Own Thinking and Writing Process

- **Comment 4:** "Collaborative writing helped me understand the gaps in my own writing."
- **Comment 5:** "When writing with a partner, I learned how to provide and accept constructive criticism."
- **Comment 6:** "Having another person's view challenges your own thought process."

Students Viewed Themselves as Scholarly Writers

- **Comment 7:** "I have come to view myself as a collaborative writer who is not only strong in her own opinions but flexible and even wanting to work with others."
- **Comment 8:** "I've learned how to use others' work to forward my own."

- **Comment 9:** “Today, I am a writer that is able to present her own voice in conjunction with the work of others, and I credit this class to helping me reach this point.”