22 Writing Science in the First Year of College: Why It Matters to STEM Students and How STEM Students Benefit from It

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Overview

This essay aims to help students who have interests in STEM fields make the most of their first year by showing them how to find opportunities to explore STEM topics in typical first-year writing classes, as well as in the STEM courses they will take, and even outside of courses; how strategies such as inquiry-based rhetoric (IRB) apply to science writing in all situations; and how the work of equity, inclusion, and antiracism are foundational to science writing.

Introduction and Background

We are writing specialists who have decades of experience working with scientists and writers. We believe that the communication of science is as important as the research itself; that the ways we approach research and writing can push against systemic inequities; and that all students have the capacity to be successful writers. For these reasons, we aim to illustrate the significance of writing as a vital part of becoming an ethical, successful scientist.

This essay will consider writing both in STEM courses and in first-year writing courses that almost all US college students are required to take. In this article, we will show you:

- the power of scientific literacy and its importance in your education
- ways to get the most out of your required first-year writing course(s)
- how to gain confidence and flexibility via inquiry-based rhetoric (IBR)

- ways to develop antiracist research and writing practices
- how to give and receive useful feedback from teachers and through peer review
- how to deepen learning and improve writing in your STEM classes
- ways to write about STEM outside your courses

The Power of Scientific Literacy and Its Importance in Your Writing Education

The successful transition to college requires adapting to different expectations and practices. In writing, this often includes moving from a rules-based approach to an *inquiry-based rhetorical approach* (IBR), which simply means studying and practicing how writers—including yourself and your classmates—earn readers' trust, make clear claims with good reasons and reliable evidence, and show why their work matters. In other words, pretty much the same goals as good science.

The discipline of writing studies, which most first year writing courses follow, believes in the power of scientific literacy to improve individual lives and communities. The scientific practices of careful study of artifacts, asking good questions, and evaluating data to arrive at evidence creates the backbone of IBR, just as in STEM. These practices help you understand the choices you have as writers. These practices help you make choices that include all community members and achieve goals based on good evidence.

The COVID-19 pandemic has illustrated the dire consequences of scientific *illiteracy*, as misunderstandings and deliberate misinformation have thwarted individual, community, and international responses by undermining respect for science. But the significance of improving public engagement in science dates back at least to the 1600s, when Bernard de Fontenelle wrote an argument for life on other planets, a book that was translated into English and became the most popular nonfiction text in colonial New England. At that time, modern science was a revolutionary discourse, which was just beginning to challenge the authority of organized religion and royalty in Europe.

While this revolution contributed to more freedom for many people, STEM fields have yet to fulfill their liberating potential. Between the 1600s and today, access to—and lack of access to—scientific thinking and its results have affected many issues, such as personal and public health, urban planning, wildlife management, environmental protection, our understanding of race and identity, space exploration—even writing. We invite you to participate in the enactment of STEM communication as an

inclusive practice by learning more about writing studies, by reflecting on your past experiences as writers, by listening closely to your peers and to scholars from diverse backgrounds, and by making inclusive choices as researchers and writers.

The field of writing studies, which has roots in classical and modern traditions of rhetoric (Murphy and Thaiss 2020), also includes empirical approaches that follow steps similar to those of scientific research: identifying questions or gaps in knowledge or methods; reviewing literature; collecting data, which often come through observation, surveys, interviews, and careful reading; data analysis; and discussion of the implications of data. For example, research in writing studies (1981) conducted by the team of Linda Flower and John Hayes used think-aloud protocols to document the cognitive processes of writers. This research—which many researchers since have questioned, refined, and built upon—contributed to a cognitive model for understanding writing, which demonstrates that one important difference between successful writers and stymied writers is that successful writers build time to revise into their process.

Ways for STEM Students to Get the Most from Required First-year Writing Course(s)

Even if your past experiences have led you to doubt your strengths as a writer, decades of research in writing studies have shown that all writers can succeed, and your first-year writing class can support your growth in STEM fields in several ways.

First, as you get into the course, look for connections between your interests in STEM and the course. The writing assignments you get in your first-year writing course will be intended to help you develop your general academic writing skills as a college student, but may not initially appear to provide opportunities to write in ways that scientists or engineers write as part of their work. But, as you learn about the assignments and procedures of the course, seek opportunities to connect those assignments with STEM topics you want to write about. For example, most first-year writing courses require some form of **research writing**: most of these assignments will require you to consult sources—and then use those sources to develop your own ideas. (For more on this topic, check out Stephen Lessner and Collin Craig's "Finding Your Way In: Invention as Inquiry Based Learning in First Year Writing," *Writing Spaces*, Vol. 1.)

Second, most of these required first-year courses want students to write about subjects they are interested in—the courses allow choice of topics.

Talk with your instructor regarding topics you might like to pursue. Even if your instructor does not have a formal background in STEM research, the instructor can help you connect your interests in STEM with the classwork and will provide useful feedback on your writing.

For example, one of Stephanie's students who was enrolled in a class on the topic of gardening at Bates College found a way to research her interests in the science of ecology by creating a project on pollinator habitats. A student in a class that she taught about place-based writing at Unity College researched the impact of dams on fish migration. A student in a class about culture she taught at Stony Brook University researched the relationship between culture and nutrition. These examples suggest how you might connect your interests in STEM fields to your writing class.

Third, one common assignment in first year writing classes asks students to reflect on their past experiences with reading and writing. Ask your instructor if you can include your interests in STEM in this assignment. For example, in the classes Chris teaches in Writing in Science, he asks students to write about themselves as scientists and writers. The assignment, "Writing and Science—Your History," asks students to respond to four questions:

1. What are ways that writing has related to your interests as a student and scientist? Describe one or more examples.

2. Have you seen a relationship between your growth as a writer and as a science student? Has one influenced the other? Or have they developed along different, even contrary, paths? Recall specific moments of growth—or frustration.

3. Regarding your future goals, what do you see as challenges for you as a writer and as a scientist?

4. What roles do you see writing playing in your ideal scientific future?

The assignment helps his students set goals for the Writing in Science course—they say that no one has asked them these questions before. Some responses reveal that writing about science has been an important part of their growth. This relationship is true for students whose STEM teachers made writing part of their classes in high school or in college. It's also true for students who decided on their own to write about their scientific interests—in a blog, for example, or on Instagram, or other social media. Or for students who have gone beyond their classes to create presentations

for science research competitions—or to write about their STEM work for college applications!

But more of Chris's students say that they have done little writing about their STEM interests—especially in school. Many see school writing as divorced from science, mainly because these students have rarely written in their high school science classes. Their high school writing has been mainly in language arts classes, and in forms, such as essays about literature, that they see unrelated to their interests in STEM. Even more troubling, many of his students have developed fear of writing and look for ways to avoid it.

If you have had experiences like these, it is even more important to look for ways to connect your STEM interests to your first-year writing course, as ways to build your skill and confidence.

How to Gain Confidence and Flexibility via Inquiry-based Rhetoric (IBR)

One way to build confidence in first-year writing is to develop what neuroscientists call *metacognition*, also known as thinking about thinking. For writing, this means assessing your past work and your writing processes. When have you felt good about yourself as a writer, in school or out? What mistakes have you made that you have learned from? How can you take these lessons to new situations?

Metacognition is an essential part of *inquiry-based rhetoric* (IBR), which we introduced earlier. Learning *inquiry-based rhetoric* (IBR) takes time and practice, just as learning lab techniques and applying formulas does. And, just as determining which methods, pipettes, or formulas to use requires experience and the ability to make judgements about the purpose of the experiment and the context, so IBR relies on experience and the ability to make judgements about the purposes, audiences, and situations of the writing.

IBR works against the common misperception of writing as a set of rigid rules. For example, you may have been told never (or always!) to use "I" in your writing, or that every paragraph should have 4-7 sentences, or that all papers have a thesis at the end of the first paragraph. You might also have observed that most published writers, including in STEM, rarely follow these "rules." IBR teaches students how to move beyond so-called 'rules' and instead to understand the choices writers face when composing in various situations (contexts) for diverse readers (audiences) and to make savvy choices.

IBR is part of the broader field of rhetoric, which you will hear about in your first-year writing courses. In brief, rhetoric has two parts. The first part focuses outside the text: on the writer's *purpose*, *audience*, and *context*. The second part focuses on the text itself: use of *logic*—the ability to make clear claims with related reasons and reliable evidence; *character*—the ability to earn your readers' trust; and *emotions*—the ability to show why the work matters. In many writing classes, you will be taught to read rhetorically: analyzing ways writers use logic, emotions, and character to achieve their purposes for their intended readers.

Strengthening STEM Writing through Cultural Rhetorics and Antiracism

Some writing classes will introduce you to a particular form of rhetoric known as *cultural rhetorics*, and you might have an instructor who practices *antiracist pedagogies*. Cultural rhetorics are "the study and practice of making meaning and knowledge with the belief that all **cultures** are rhetorical and all **rhetorics** are **cultural"** (Bratta and Powell 2016). Cultural rhetoric changes rhetorical analyses and practices in significant ways by illustrating the richness of knowledge available when we pay attention to the work of people who have historically been marginalized in Western, colonial academic institutions in general and in STEM fields in particular. Developing scientific literacy practices that follow principles of cultural rhetorics includes asking questions about audience, purpose, context, logic, emotions, and character. It also requires understanding the impact of racism and other forms of systemic inequality on our personal perspectives and our cultural traditions—including scientific methods and knowledge.

Some scholars and teachers have developed antiracist teaching practices to ensure their classes are inclusive spaces that serve the needs of all students, that value the various forms of knowledge students bring to class, and that use the classroom to address systemic inequities such as racism and sexism. Antiracist teaching practices in STEM and in writing acknowledge that systemic inequity, implicit biases, and micro-aggressions disadvantage Black people, Indigenous people, People of Color, first generation college students, and other people who have been minoritized due to their skin color, ethnicity, gender identity, sexual orientation, and class. Antiracist teaching and writing practices aim to correct these inequities in a number of ways.

For example, Chris's classes of STEM majors from the sciences and engineering are highly diverse ethnically and linguistically. Some writ-

ing assignments in these classes are multimodal (using video, photography, and infographic charts, as well as written texts in accessible language). Each student chooses an audience (family members, home communities, special-interest groups, etc.) they would like to reach. Designs of projects use multimodal tools that the students feel can reach the audiences they choose, so that these readers can, the students hope, improve their lives. Sample projects include, among many possibilities, brochures and infographic charts on health topics for medical offices visited by children and parents in communities of color; websites, blogs, and calendars (some multilingual) on nutrition, agricultural practices, and new technologies; oral-visual presentations to high schoolers that encourage them to consider STEM fields.

Nationally, the American Association of Colleges and Universities (AAC&U) through its *Project Kaleidoscope* (PKAL) sponsors annual conferences on Transforming STEM Education. PKAL's central goal is increasing the representation—and success—of BIPOC students and researchers in all STEM fields. Moreover, because many STEM fields have historically failed to recognize and advance the careers of women and of LGBTQ+ scholars, AAC&U has also made gender inclusiveness a continuing goal.

What this means for you as a student and a writer with interests in STEM will depend on your own background; the intersections of race, class, gender identity, sexual orientation, and language in your identity and experience. You will want to reflect on the possibility that you have implicit biases and should work to overcome them. If you come from a privileged background, you will want to be attuned to the possibility that you engage in micro-aggressions and you will need to learn alternatives. If you are a first-generation college student or a BIPOC student, you may want to know about the resources available to help you navigate systems of oppression. Many campuses have programs and offices devoted to supporting students from minoritized backgrounds. #ShutDownSTEM offers many resources organized to address various backgrounds.

You will also want to learn to look for bias in research because much scientific research is inflected by racism and sexism. This bias shows up in the types of questions investigated, the subjects chosen, the types of evidence valued, the methods selected, the language used, and the metaphors employed. "Want to Dismantle Racism in Science? Start in the Classroom," a conversation between science educators, illustrates problems such as the erasure of Black scientists from history, and offers solutions to address racism. For more information in regard to gender, check out Emily

Martin's 1991 article, "The Sperm and the Egg: How Science Has Constructed a Romance based on Stereotypical Male-Female Roles."

In addition to analyzing your behavior and analyzing bias in STEM research, you can actively transfer antiracism to your STEM classes by:

- Working in diverse groups
- Listening across difference
- Creating research questions that serve underrepresented people
- Engaging in inclusive citation practices
- Using inclusive language

The 2020 Conference on College Composition and Communication statement "This Ain't Another Statement! This is a DEMAND for Black Linguistic Justice!" offers important information and resources on antiracism and college writing. You will also find deeper explorations of language justice in two essays in *Writing Spaces*, vol. 4: "Workin' Languages: Who We Are Matters in Our Writing" (by Sara P. Alvarez, Amy J. Wan, and Eunjeong Lee) and "Beyond Language Difference in Writing: Investigating Complex and Equitable Language Practices" (by Christina Sánchez-Martín).

Building Confidence and Rhetorical Awareness through Feedback and Peer Review

Learning *inquiry-based rhetoric* (IBR) develops your metacognitive writing process. To achieve this, you'll closely read your draft to identify which parts you most want your reader to comment on. If your instructor has given you a rubric (list of questions) for the assignment, you can use it to analyze your work, then to frame your request for feedback. If a rubric is not provided, create your own. As an example, here's a rhetorical rubric we provide:

	Questions to Help Writers Set the Agenda for Feedback
Logic	**Questions about Critical Thinking and Logic** • What is my central claim? • What reasons do I give? • Is my evidence reliable?

Emotions	**Questions about Why the Work Matters** • What gap in research or knowledge of the subject does my work address? • Why does this matter? • What are the implications of my work that I've stated? • What next steps do I see for this research?
Character	**Questions about Genre and Reader Expectations** • What organizational patterns do I follow? • What are the relationships between my points? • Do I provide appropriate detail about my methods and materials? • Who does this research serve? • Are my research methods ethical? • Do my visuals accurately represent my results? • Do I use inclusive language? How understandable would I be to someone reading this draft? • Do I follow ethical and inclusive citation practices (Bali 2020)?
	Questions about Your Goals and Process • How did I generate material, draft, and revise this paper? What worked? What should or might I do differently? • What were my goals as a writer? How did I achieve them? Where would I like to continue to improve?

In addition to feedback from instructors, you will most likely give and receive feedback from classmates via **peer review.** You and the other members of your class will learn how to read your classmates' writing rhetorically, appreciate its strengths, and suggest improvements. Peer review is a vital learning opportunity; it sparks insight into how others conceive writing tasks similar to yours. It gives you permission to ask for their careful response to your work.

Moreover, as a STEM student, you already know that knowledge in any scientific field grows primarily through **peer review,** by which practitioners are called on to review grant applications and articles submitted for publication. If you use the opportunity in your writing class to learn how to perform peer review carefully and respectfully, you will get closer to

becoming a STEM student whom future colleagues will value. Successful peer review requires practice in rhetorical reading, which we describe in the next section of this essay. As you perform peer review, you might use a rubric such as that we showed earlier, one designed by your instructor, or one you might create. Find more information about peer review in Ron DePeter's "How to Write Meaningful Peer Response Praise," in *Writing Spaces,* vol 3.

Beyond the First-Year Writing Course: Writing in STEM Classes

In STEM writing, as part of IBR, authors establish their character and earn the trust of readers in several ways that depend on the genre in which the author is writing and the audience the writer aims for. STEM writers situate their work in previous research, summarizing relevant publications; they carefully describe their methods and illustrate their data in clear charts, graphs, and other visuals. STEM writers, like other writers, make clear claims about what their results mean as well as about the limits of their results.

For the genre of formal scientific lab reports for academic audiences, writers carry out IBR through the format of the IMRAD report, which in the 20th century became standard in STEM journals. The IMRAD acronym means Introduction, Materials and Methods, Results, And Discussion. The IMRAD structure includes the following sections:

- An Abstract that summarizes the overall report
- An Introduction that summarizes prior research on this topic, then states the gap in knowledge, the purpose of this research, and perhaps a hypothesis
- A Materials and Methods section that describes the tools used and the steps in the research process
- A Results section that reports the principal findings of the research
- A Discussion section (including a conclusion) that states what the authors consider the significance of the results and necessary further research.

You may be fortunate in your first year to be in a STEM course that actually asks you to read and write in the IMRAD form, perhaps in a lab section that accompanies a large lecture. Writing IMRAD-style reports, as well as reading closely the research articles in journals, will definitely

build your powers as a scientific thinker. These articles will often challenge students through difficult, highly technical language, but learning to read and understand these articles is critical for your growth as a scientist.

But other than the practice you'll get in such a course, how do you learn to do these IMRAD exercises well? Fortunately, many guides online as well as STEM writing textbooks focus on the IMRAD report (see our list of resources). Because every journal in science contains articles that use the IMRAD structure, you'll have many opportunities to study articles that will help you learn how to do IMRAD well.

Another helpful practice is to use *rhetorical reading* as a way to apply IBR. Compare articles on the same subject and consider how and why the subject is written about differently. Is there another way that the subject could be written about that seems clearer or truer to you? Put your thoughts into writing. Try out different ways to say things on subjects of interest to you.

You can actively "transfer" the skills of rhetorical reading from your first-year writing class to your work in STEM by analyzing how texts in STEM fields use emotional appeals. (For a fuller discussion of such transfer of ideas, see "The Importance of Transfer in Your First Year Writing Course" by Kara Taczak, *Writing Spaces*, vol. 4.) In STEM writing, authors typically create emotional appeals by demonstrating a gap in the prior research and by explaining the implications of their research to show why their work matters. In the example below, an article titled "A Systematic Review of Empirical Research on Self-Reported Racism and Health" by Yin Paradies (*International Journal of Epidemiology,* 2006), the author briefly summarizes previous studies and then build emotional appeals by noting that his work *updates* and *expands* prior work.

> A handful of previous reviews have attempted to provide an overview of certain aspects of this emerging area of epidemiological research. The first article to consider the health impact of racism (along with sexism and social class) was published by Krieger *et al*. in 1993. This was followed, in 1999, by a review, also by Krieger, of 15 studies examining ethnic and/or racial discrimination and health_and, in 2000, by a review of 13 studies examining racism and mental health for African Americans by Williams *et al*. There were also three reviews published in 2003, with Wyatt *et al*._summarizing 19 studies relating racism to cardiovascular disease for African Americans, Brondolo *et al*._discussing studies relating racism to blood pressure (six studies) and cardiovascular reactivity (11 studies), and Williams *et al*._reviewing 53 population-based

> empirical studies of ethnic and/or racial discrimination, which were published from 1998 onwards and related to various health outcomes. Drawing in particular on the most recent review by Williams *et al.*, this paper updates and expands upon these earlier reviews by examining the key characteristics of epidemiological studies of self-reported racism and health—where and when studies have been conducted, the race, age and gender of study populations, study designs, sample sizes, and data sources used. (n.p.)

At the end of the introduction, the author further develops his emotional appeals by signaling that his research has important implications in regard to the health of those who experience racism:

> The nature of associations found between self-reported racism and health is detailed for a range of health outcomes across various study and exposure characteristics along with identified effect modifiers and mediators of these associations. (Paradis n.p.)

Conversely, many first-year STEM courses do NOT give you the opportunity to write reports but are primarily lecture-and-reading courses. These require you to memorize principles, formulae, and substances, on which you will be tested.

Nevertheless, even these courses present opportunities to write to enhance your learning of facts and principles:

- Teachers may include online exercises to help you understand and apply the material. As you engage in these exercises, you solidify knowledge and build powers of expression—even if the process seems difficult at first.
- Because STEM courses often require you to read textbooks in print or online, write notes and explanations for yourself as (1) means to understand all those terms and ideas and (2) make it easier for you to put those terms and ideas into wording that you are comfortable with and likely to remember.
- *Memorizing* means making your perceptions and your connections between ideas part of *your working memory*. Every time you think about a concept and try to express it in related words, you are building your ability to draw on that concept in multiple situations. That is why *writing about ideas and associated concepts* works so well as a memorizing exercise. The same goes for other memorizing methods: drawing, diagramming, and discussing ideas with others. Consider all the ways you have memorized an idea—or perfected a skill—that is important to you. What tools have you

employed to learn that idea or skill so that you can remember and apply it?

Writing about Science Outside Your Courses

Beyond your courses, you may have discovered ways to use writing to deepen your STEM learning and build your powers of expression. Here are some widely-used methods:

1. Start your own blog.

Blogs have proliferated in every STEM discipline (just Google "STEM blogs" and you'll see). Set one up using Blogspot, Wordpress, or another tool. You don't need to publish your blog, but you can if you wish to build a readership. You can start out using your blog as a writing and learning space just for yourself; you can make it public as you gain confidence. Four rewards of blogging:

- Keep a record of your thinking, and return to earlier entries to see how you've grown, which contributes to metacognition
- Read other bloggers, to get ideas for your own blog or perhaps begin to build a blogging community in your area of interest
- Experiment with photos, videos, audio, infographics, and charts
- Practice different writing styles and writing for diverse readers—children, parents, friends, people you admire, people who think differently from you.

2. Write to memorize and reflect on your reading.

Writing about what you read helps you to (1) understand it, (2) remember it, and (3) evaluate it. Too often, students assume that what they read in textbooks or hear in lectures is merely information to be spit back on tests. But *to be a scientist*, you need to become a strong reader: to develop a critical eye and ear not only for *what* other writers write, but also *how* they write. If you learn IBR, you'll have a framework for this analysis. For example, when you read a scientific journal article or a popular article about science, look carefully at how the subject is described. Note differences from one article to another. Ask yourself: "how might I say this differently?"

3. Write about science via social media.

Facebook, Instagram, and TikTok allow for *multi-modal communication*—in words, photos, drawings, video, and sound. They allow researchers to share work in progress. By participating in these conversations, you'll

- learn from ways others use multimodal tools
- learn about emerging research, and
- practice multimodal communication

Moreover, most of these platforms limit the number of words, so you'll practice how to communicate succinctly.

Conclusion

This brief guide introduces you to tools to make the most of opportunities you have in your first year of college to build your skill as a writer and learner in STEM. Equally important, we've explained a conceptual framework, *inquiry-based rhetoric* (IBR), to apply to all the reading and writing you will do in college. This framework includes a related system, *antiracist cultural rhetorics,* that can expand your rhetorical expertise, so that how and why you communicate becomes more inclusive and versatile—while helping in the effort to overcome historical inequities among people, especially in STEM fields.

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Teacher Resources for "Writing Science in the First Year of College: Why It Matters to STEM Students and How STEM Students Benefit from It"

Overview and Teaching Strategies

This essay aims to help students who have interests in STEM fields make the most of their first year by showing them how to find opportunities to explore STEM topics in typical first-year writing classes, as well as in the STEM courses they will take, and even outside of courses; how strategies such as inquiry based rhetoric (IRB) apply to science writing in all situations; and how the work of equity, inclusion, and antiracism are foundational to science writing. This essay might be assigned as an option in the beginning of a first-year writing class to reassure STEM students that the FYW course is relevant to their needs. Parts of it might be assigned to prepare students for class work, formal writing activities, and peer review. Also, the essay might be used in first-year STEM classes to explain the importance of writing throughout STEM, or used in other ways depending on the goals and assignments of the specific course.

Throughout the essay, specific uses of writing, sample assignments, and rationales for these are described so that students can employ these tools and teachers can adapt them. Each of the questions below can be turned into a classroom activity by having students work in small groups (in class or in Zoom breakout rooms). Students can share highlights from their small group discussions orally, by writing notes on the classroom chalkboard or white board, by writing notes in collaborative Google Docs, or by writing in class forums set up by their instructors in first-year writing courses or in first-level STEM courses.

Discussion Questions

1. In the section "Ways for STEM Students to Get the Most from Required First-year Writing Course(s)," we discuss ways that students can explore their interests in STEM in their first-year writing classes. Make a list of your interests. Then review your syllabus for your first-year writing class. Note the places in the syllabus where

you think you could explore your interests. If you feel stuck or just have questions, talk with your instructor.

2. We propose IBR (inquiry-based rhetoric) as an alternative to rules-based writing classes. What rules do you remember being taught about writing? How often do you see published writers—including writers in STEM—following these rules? Look for examples of published writers breaking these rules, following other rules, or making their own.

3. In the section on the first-year writing course, we explain how students with STEM interests can expand the typical literacy narrative assignment to include their interests. How did you become interested in STEM? Make a timeline of your life and jot down the moments that have been important to you regarding the development of your interests in STEM. Continue the timeline to project what your future might look like.

4. In the section "Building Confidence and Rhetorical Awareness through Feedback and Peer Review," we offer a rhetorical rubric to help you understand what makes good writing in different genres, for different audiences, and different purposes. Think about your own ideas of good writing. How does the rhetorical rubric match your ideas of good writing? What does it add? What does it leave out?

5. In the section "Strengthening STEM Writing through Cultural Rhetorics and Antiracism," we introduce the connections between antiracism and STEM and call upon readers to reflect on their individual backgrounds to facilitate the process of making STEM more equitable and inclusive. In what ways has your background prepared or failed to prepare you for this work? What resources does your campus offer? What next steps might you take to support yourself and your classmates in the project of improving equity and inclusion in STEM?

6. In the section "Writing about Science Outside of Courses," we suggest that blogs and social media such as Facebook provide important opportunities for you as a science writer. Do you have a favorite blogger or science writer who uses social media? If so, find a few examples of this person's work and write about why you follow them. If not, spend some time exploring your STEM interests on

your favorite social media (for example, using hashtags) and see what you find.

7. In the same section, we write about how social media and much popular science writing "allow for *multi-modal communication*—in words, photos, drawings, video, and sound." If you read such popular science periodicals as National Geographic, or STEM blogs and popular STEM websites, you'll know many examples of multi-modal STEM communication. You may also have heard of STEAM—the joining of STEM research with the arts. Have you engaged in multi-modal STEM? If so, write about what you've tried. If not, write about how you might experiment with communicating your STEM interests through some of these media.

8. In the section "Beyond the First-year Writing Course: Writing in STEM Classes," we note that "*writing about ideas and associated concepts* works so well as a memorizing exercise." To what extent have you used writing as a tool to help you understand and remember ideas, events, or procedures important to you? Reflect on when and how you have used this tool. Can you think of times when you've realized that you should have been more careful to make notes or write about what you had wanted to remember?

Activities for Teaching Rhetorical Reading

In addition to turning the discussion questions above into classroom activities, the following activities related to rhetorical reading can help teachers extend our essay. While we offer the "rhetorical reading rubric" (below) to help guide peer review, this rubric can be used to guide students through the rhetorical reading of the texts the teacher assigns in class:

1. The teacher might assign two or more texts on the same topic in different genres, such as a news article, a blog post, and a research article.

2. The teacher might assign two or more texts from different disciplines on the same topic.

3. The teacher can model rhetorical analysis in class by pointing out features of text as we do using the article by Paradies cited in the essay.

4. Students can continue rhetorical analysis by engaging in informal writing for homework and then share their work in class.

5. The teacher can build these activities into a formal rhetorical analysis assignment that asks students to evaluate the different rhetorical moves writers use in different situations and to consider how they might use these moves in their own writing.

Rhetorical Reading Rubric

Logic and critical thinking:	• The document presents clear claims/points with related reasons supported by reliable evidence.
Emotions (gets the reader to care):	• The document shows how this research addresses a gap in prior research, and (2) shows why this research matters to other researchers or to a broader community.
Character (earns the trust of the reader):	• The document shows understanding of relevant background research. • The document clearly explains methods and relevant materials. • The document uses visual techniques to achieve clarity. • The vocabulary used is accessible to the intended readers. • The document follows the general conventions of writing in the genre and discipline; for example in organization, format, and sentence style.

Activities to Incorporate "Writing to Learn"

Our section "Beyond the First-year Writing Course: Writing in STEM Classes" describes the cognitive and metacognitive benefits of regularly using writing as a tool for memorization and for expanding thinking. It notes that "teachers may include online exercises to help [students] understand and apply the material." Teachers might consider the following:

1. At the beginning of a lecture, pose a question to students related to the theme of the lecture: e.g., "when you hear the term x, what do you think it means? What doesn't it mean?" Ask students to write for just one minute without Googling the term. The question will immediately engage their attention and focus.

2. As the final task toward the end of a lecture, ask students to write for 2-3 minutes to record thoughts/notes about the content of the lecture, perhaps phrased as "information and ideas that you don't want to forget." Such writings might be recorded in an online forum on the teacher's course learning management system.

3. Consider devoting a small part of class time at the beginning of a term, especially in introductory courses for first-year students, to the value of writing as a tool of thinking, remembering, and applying ideas. Consider describing to students your own practices as a researcher who takes careful notes and uses writing informally to expand your thinking.

4. Teachers who set up student writing forums such as that described in a. and b. (above) might consider how frequently they will read or just browse them, and if they will grant them a small amount of course credit. Keep in mind that the writing of exercises like a. and b. is totally informal and spontaneous, and should always be a space for students to write without fear of evaluation. Indeed, teachers might tell students that such spontaneous writings should only be done in personal writing spaces that the teacher will have no access to.

5. Conversely, teachers also may set up such forums more formally, often using them as quasi-public spaces open only to class members and the instructor. These often include regular deadlines, such as weekly, with named topics. In addition to giving students regular incentives to write about their reading and subjects of study, these forums are often used to build a course community, with expectations that students will read one another's entries.